

Injuries in the Military

A Hidden Epidemic

A Report for the
Armed Forces Epidemiological Board
November 1996

By
The *Injury Prevention and Control Work Group*
of the Armed Forces Epidemiological Board

With Contributions from
Department of Defense Injury Surveillance and Prevention Work Group
of the Office of the Assistant Deputy Under Secretary of
Defense for Safety and Occupational Health

Foreword

The Armed Forces Epidemiological Board, a civilian group of advisors to the Assistant Secretary of Defense for Health Affairs, has maintained a long standing interest in understanding the nature and size of the problem injuries pose for the military. The Armed Forces have also shown an ongoing concern about injuries, and their impact on training and on the readiness of the force. The Board formed an Injury Prevention and Control Work Group as a result of its growing awareness of the high costs of injury for the military in terms of manpower losses, medical care expenditures and other resources. The goals set for the Work Group were to determine the extent of the effect of injuries on the health of military personnel and to identify potential causes, risk factors, or other variables which could be modified to reduce the impact of injuries on readiness. The Board recognized that injury prevention requires a comprehensive medical database in order to target the most important causes of morbidity, mortality and disability.

The Injury Prevention and Control Work Group of the AFEB was charged with examining the sources of information which are currently available for the surveillance of injuries and their outcomes, and with considering the sufficiency of those data sources for drawing valid conclusions about the incidence and causes of injuries. The Work Group had a further mandate to comment on the usefulness of these sources for developing strategies to prevent injuries. After reviewing the data from many sources, the Work Group developed recommendations for ways readily available data could be used more effectively to track the incidence and reduce the impact of injuries. The Work Group also commented on ways the databases themselves could be improved.

In accepting the recommendations of the Injury Prevention and Control Work Group, the Armed Forces Epidemiological Board has focused upon the critical need for further development of military medical surveillance systems for injuries and disease in order to facilitate more efficient and effective prevention programs. A Tri-service system for routine medical surveillance will provide for major improvements in the ability to identify needed research and development, will help to identify clear targets and steps for prevention initiatives, and will provide timely data on changes in the nature and possible causes of injuries.

The Board and Work Group appreciate the work of the Department of Defense Injury Surveillance and Prevention Work Group sponsored by the Office of the Assistant Deputy Under Secretary of Defense for Safety and Occupational Health. The DOD Work Group's efforts made possible the AFEB Work Group's evaluation of the potential surveillance data resources.

The Armed Forces Epidemiological Board commends the military on its continued attention to the problem of the injuries, and encourages further strengthening of both the surveillance systems and research efforts devoted to prevention of injuries. Improvements in injury and medical surveillance systems will lead to improved prioritization and allocation of resources, more successful prevention strategies, and greater enhancement of the health and fitness of the military personnel now and into the future.

We appreciate the opportunity to be of service to the men and women of our armed forces.

Barbara C. Hansen, Ph.D.
Co-Chair of the Injury Prevention and Control Work Group

Lewis Kuller, M.D.
President, Armed Forces Epidemiological Board

Table of Contents

Foreword	i
Dr. Barbara C. Hansen	
Dr. Lewis Kuller	
Executive Summary	iv
COL Bruce H. Jones	
Armed Forces Epidemiological Board, Injury Prevention Work Group Members	vii
Assistant Deputy Under Secretary of Defense for Safety and Occupational Health, Department of Defense Injury Surveillance and Prevention Work Group Members	ix
Introduction	xi
COL Bruce H. Jones	
Dr. Barbara C. Hansen	
Chapter 1 - Deaths Due to Injury	1-1
Dr. Kenneth E. Powell	
Dr. Christine M. Branche-Dorsey	
Ms. Lois A. Fingerhut	
Dr. Dennis Perrotta	
Chapter 2- Disabilities Due to Injury	2-1
Dr. Thomas J. Songer	
Dr. Ronald E. LaPorte	
Chapter 3- Hospitalization Due to Injury	3-1
Dr. Gordon S. Smith	
Dr. Andrew L. Dannenberg	
Dr. Carol Runyan	
Chapter 4- Outpatient Care for Training and Other Injuries	4-1
Dr. Kenton Kaufman	
CAPT Stephanie Brodine	
CDR Richard A. Shaffer	
Chapter 5- Casualties During Combat Due to Non-Battle Injuries	5-1
Mr. Jim Writer	
LTC Robert DeFrait	
Chapter 6- Injury Work Group Conclusions and Recommendations	6-1
COL Bruce H. Jones	
Chapter 7 - Board's Conclusions and Recommendations	7-1
Dr. Dennis Perrotta	
Appendix A-Summary Conclusions and Recommendations for Each Chapter	A-1
Appendix B-Minimum Basic Data Sets For Unintentional (Accidental) and Intentional Injuries.	B-1

Injuries in the Military: A Hidden Epidemic

Executive Summary. Although the Military Services have recognized that injuries affect the health and readiness of military personnel, the extent of the problem has not been fully appreciated. Over the last several years, the Armed Forces Epidemiological Board (AFEB) became increasingly aware of the magnitude of the problem with injuries for the services -- in particular, the Army and Marine Corps. In March, 1994 in response to a request from the Office of the Surgeon General of the Army, the AFEB formed the Injury Prevention and Control Work Group. The Work Group's primary objectives were to answer three questions:

- a. How big is the problem with injuries for the Military Services?
- b. What information systems exist to support a comprehensive, integrated injury prevention and control effort?
- c. What needs to be done to more effectively prevent injuries?

Key Conclusions.

- a. Injuries have greater impact on the health and readiness of U.S. Armed Forces than any other category of medical complaint during peacetime and combat.
- b. Disability compensation for injuries alone exceeds \$750 million dollars per year.
- c. Training injuries treated on an outpatient basis may have the biggest impact on readiness.
- d. Back and knee injuries constitute a significant proportion of morbidity, disability and limited duty in the Services.
- e. Sports injuries, motor vehicle crashes and falls are the leading causes of injury for the Services.
- f. Valuable automated databases for medical and injury surveillance exist but are not routinely analyzed for policy and prevention implications.
- g. In addition to improved use of surveillance, more research is needed to identify modifiable risk factors and mechanisms of injury, and to evaluate prevention strategies.

Recommendations for Improvements in Surveillance of Injuries.

- a. Establish automated, population-based, medical surveillance systems which will:
 - (1) Link hospitalization, disability (PEBs/MEBs) and fatality data systems at the central medical surveillance site.
 - (2) Develop sentinel site outpatient surveillance systems (or other cost effective surveillance until automated records are available Service wide).
 - (3) Continue refinement of surveillance strategies appropriate for combat and other deployments.
 - (4) Routinely link medical surveillance data on injuries with Safety Center/ Agency data on causes of injury events.
- b. Collect at least the minimum data sets recommended by the International Collaborative Effort on Injury Statistics (1995), see Appendix B.
- c. Standardize collection, coding and reporting of injuries across the Services.
- d. Routinely assess the completeness and validity of surveillance data.
- e. Improve cause of injury data collection.
 - (1) Collect cause coding for musculoskeletal conditions (ICD-9 Codes 716-736).
 - (2) Collect a free text field for cause of injury in surveillance data bases.
- f. Refine definitions and coding of work and nonwork-related injuries.
- g. Exchange injury data from medical surveillance systems with the Service Safety Centers/Agencies and other key prevention stakeholders.
- h. Convene Tri-Service workshop on injury surveillance and prevention including key DOD stakeholders (Safety Centers and others).
 - (1) Establish partnerships to facilitate Tri-Service collaboration and coordination.
 - (2) Prioritize immediate and long-term surveillance, research and prevention goals.

Recommendations for Injury Research

- a. Prioritize allocation of resources for research based on the magnitude and severity of morbidity and the probable impact on readiness.
- b. Conduct research to identify modifiable risk factors and mechanisms of knee and back injuries.
- c. Develop and test strategies to reduce the incidence and severity of sports injuries.
- d. Determine risk factors for and circumstances of fall-related injuries.
- e. Expand resources for training-related injury research to include more than basic trainees/recruits, infantry and marines.
- f. Augment research on the relationships between military training, physical fitness, performance and injuries.
- g. Assure adequate resources allocated for injury research.

Recommendations for Injury Prevention

- a. Prioritize resources for prevention programs based on the magnitude of morbidity and the impact on readiness.
- b. Target knee and back injuries for additional efforts toward prevention.
- c. Place greater emphasis on prevention of training, sports injuries and falls.
- d. Implement programs designed to enhance fitness and reduce training injury rates.
- e. Monitor prevention program effectiveness.

ARMED FORCES EPIDEMIOLOGICAL BOARD INJURY PREVENTION WORK GROUP MEMBERS

The AFEB Injury Work Group members listed below wrote and edited the report "Injuries in the U.S. Military; A Hidden Epidemic."

Co-Chairmen of the Injury Prevention Work Group:

Barbara C. Hansen, Ph.D.
Director, Obesity and Diabetes Research
Center and Professor of Physiology
University of Maryland
School of Medicine
Baltimore, Maryland 21201

COL Bruce Jones, USA, MC
Chief of Environmental and Occupational
Health and Injury Control
U.S. Army Center for Health Promotion
and Preventive Medicine
Aberdeen Proving Ground, Maryland 21010-
5422

Members:

Professor Susan P. Baker, M.P.H.
Johns Hopkins University
School of Hygiene and Public Health
Center for Injury Research and Policy
Baltimore, Maryland 21205-1996

Christine M. Branche-Dorsey, Ph.D., M.S.P.H.
Epidemiologist
Division of Unintentional Injury Prevention
National Center for Injury Prevention and Control
National Centers for Disease Control and
Prevention
Atlanta, Georgia 30341-3724

Andrew L. Dannenberg, M.D., M.P.H.
Injury Prevention Center
Johns Hopkins School of Hygiene and Public
Health
Baltimore, Maryland 21205

Ms. Lois A. Fingerhut
Special Assistant for Injury Epidemiology
Office of Analysis, Epidemiology
and Health Promotion
National Center for Health Statistics
Hyattsville, Maryland 20782

Kenton Kaufman, Ph.D.
Director of Orthopedic Research
Children's Hospital
San Diego, California 92123

Ronald Edward LaPorte, Ph.D.
Department of Epidemiology
Graduate School of Public Health
Pittsburgh, Pennsylvania 15261

Dennis M. Perrotta, Ph.D.
Chief, Bureau of Epidemiology
Texas Department of Health
Austin, Texas 78756

Kenneth E. Powell, M.D., M.P.H.
Associate Director for Science
Centers for Disease Control and Prevention
Division of Violence Prevention
National Center for Injury Prevention and Control
Atlanta, Georgia 30341-3724

Carol W. Runyan, Ph.D.

Director of Injury Prevention Research Center
University of North Carolina
Chapel Hill, North Carolina 27599-7505

Gordon S. Smith, M.D., M.P.H.

Associate Professor
Johns Hopkins University
School of Hygiene and Public Health
Department of Health Policy and Management
Baltimore, Maryland 21205-1996

Thomas J. Songer, Ph.D.

University of Pittsburgh
Graduate School of Public Health
Pittsburgh, Pennsylvania 15213

Guest Authors

Mr. James Writer

and

LTC Robert DeFraités, USA, MC

Division of Preventive Medicine
Walter Reed Army Institute of Research
Washington, D.C. 20307

Military Liaison Representatives

CAPT Stephanie Brodine, MC, USN

Naval Health Research Center
Department of Health Sciences
and Epidemiology
San Diego, California 92186-5122

MAJ Kevin Grayson, USAF, BSC

Chief, Occupational Environmental
Epidemiology
Brooks Air Force Base, Texas 78235-5114

MAJ Vincent P. Fonseca, USA, MC

USACHPPM, Directorate of Epidemiology and
Disease Surveillance
Washington, DC 20307-5100

LCDR Richard A. Shaffer, MSC, USN

Naval Health Research Center
Department of Health Sciences
and Epidemiology
San Diego, California 92186-5122

LTC Sanford D. Zelnick, USAF, MC

Headquarters, AFMOA
SGPA
Bolling Air Force Base
Washington, DC 20332-5113

ASSISTANT DEPUTY UNDER SECRETARY OF DEFENSE FOR SAFETY AND OCCUPATIONAL HEALTH (ADUSD/SAFETY AND OCCUPATIONAL HEALTH) DOD INJURY SURVEILLANCE AND PREVENTION WORK GROUP

This report would not have been possible without the data on deaths, disabilities, and hospitalizations contributed by the systematic efforts of the members of the DOD Injury Surveillance and Prevention Work Group which has diligently gathered information over the last several years.

MAJ Paul J. Amoroso, USA, MC
U.S. Army Research Institute of
Environmental Medicine
Natick, MA 01760-5007

COL Eric Evenson, USA, MC
HQS DA
Office of the Surgeon General
Falls Church, VA 22041-3258

COL John W. Gardner, USA, MC
Department of Preventive Medicine
and Biometrics
Uniformed Services University of Health Sciences
Bethesda, MD 20814-4799

CDR James Helmkamp, USN
National Institute of Safety and Health (DSR) MS
108p
Morgantown, West Virginia 26505

LCDR Gregory Hempen, USN
Naval Safety Center
Naval Air Station
Norfolk, VA 23511-5796

COL Bruce H. Jones, USA, MC
Chief of Environmental and Occupational
Health and Injury Control
U.S. Army Center for Health Promotion
and Preventive Medicine
APG, Maryland 21010-5422

Mr. Al Lillibridge
Safety Office
Commandant of the Marine Corps (SD)
HQ, Marine Corps
Washington, DC 20380-1775

Mr. Bob Parli
Safety Office
Headquarters U.S. Air Force
Pentagon
Washington, DC 20330-1400

LTC Chip Patterson, USAF, MC
Office of the Assistant Secretary of
Defense for Health Affairs
Pentagon
Washington, DC 20301-1200

CAPT Ken Saint Andre, USN, MC
Office of the Assistant Secretary of Defense
Health Affairs
Pentagon

LTC John Seibert, USAF, MSC
Directorate of Safety and Occupational
Health Policy
Deputy Under Secretary of Defense
(Environmental Security)
Arlington, VA 22202-2884

COL Hugh Wolfe, USA, MSC
Assistant Secretary of the Army
Installations/Logistics/Environment
Washington, DC 22310-0110

LTC Hank Woodcock, USAF

Bioenvironmental Engineering Program Manager
HQ AFMOA/SGPA Office of the Surgeon General
Headquarters Air Force
Bolling AFB, Washington, DC 20332-5113

Mr. William Wortley

Department of the Army
Office of the Chief of Staff
Army Safety Office
Washington, DC 20310-0200

INTRODUCTION

Section 1. Background

a. Injuries cause more deaths than any other health problem confronting military personnel and result in significant manpower losses. Nevertheless, the U.S. military does not fully appreciate the magnitude of the impact injuries exert on the health and readiness of military personnel. Regular reports from all the Services show that accidental injuries are the leading cause of death (DIOR, Worldwide Casualty Report, 1994); however, no routine reports document the large numbers of injuries treated in ambulatory care clinics, emergency departments, and hospital outpatient clinics. Many of the injuries treated in these outpatient settings are relatively serious and cause a great amount of disability. While the safety agencies of the military services track the occurrence of the more serious acute traumatic accidental injuries, no organization monitors or reports the recurrent, chronic or late effects of injuries. Because of these deficiencies in data systems and reporting, injuries in the military remain a largely hidden epidemic.

b. Although multiple data sources on injuries exist for all the military services, few of these are routinely used to measure the impact of injuries on the health and readiness of military personnel. The few reports that do examine the relative importance of injuries, compared to other causes of morbidity and mortality, rarely do so from the perspective of more than one of the potential information sources at a time (usually only deaths or hospitalizations). Therefore, a major objective of this report is to bring together, data from the multiple, diverse and frequently untapped sources of injury data. By providing a more complete view of the extent of the injury problem, it is hoped this report will catalyze development of more effective surveillance and prevention systems by the Military services, just as the National Academy of Sciences 1985 report, *Injury in America*, did for the country.

c. Understanding why the Armed Forces Epidemiological Board (AFEB) formed the Work Group that wrote this report requires background information on injuries in the military. This information will be drawn primarily from two sources:

- (1) Briefings to the AFEB on the issue of injuries.
- (2) Reports published in the medical literature.

A brief history of the AFEB's past and recent interest in injuries will be provided.

Section II. Injuries During Peacetime Military Training and Operations.

a. Deaths are the most completely and consistently reported medical data in the military. The Department of Defense (DOD) and the Service Safety Centers routinely report data on deaths of military personnel. These data show that injuries have been the leading cause of death among military personnel during peacetime over the last 15 years (DIOR, Worldwide Casualty Report, 1994; Helmkamp, JC. Milit Med, 1986). During this period, injuries accounted for four times as many deaths among military personnel as all diseases combined. As a result fatal injuries, especially unintentional ones, have been a primary focus of concern and safety programs. In terms of the number of military personnel affected, however, fatalities have had relatively small impact on readiness compared to nonfatal injuries.

b. Data presented to the AFEB in recent years suggest that from the standpoint of manpower losses, nonfatal injuries have a greater effect on U.S. military forces than deaths. For example, in 1989 injuries and musculoskeletal conditions caused more than 33,000 soldiers to be hospitalized, almost 30 percent of the 115,000 admissions that year (Jones, BH, AFEB presentation, Feb. 1994). That same year fewer than 500 soldiers died due to injuries. From 1980 to 1990 injuries were the leading reason for hospitalization of Army personnel and resulted in more soldier noneffective days (i.e. days a soldier was either in a hospital bed or on convalescent leave) than any other reason (unpublished report, Army Patient and Administration Division, Ft Sam Houston, TX, 1991). Army-wide it can be estimated that injuries resulted in more than 350,000 soldier non-effective days annually during the 1980s. Looking at Air Force data, in 1992 fewer than 200 personnel died from injuries (DIOR, Worldwide Casualty Report, 1992), but over 14,000 were hospitalized for injuries and other musculoskeletal conditions. Hospitalizations resulting from injuries to military personnel not only occur frequently, but they cause great losses of manpower and absorb other resources.

c. In addition to hospitalization, injuries result in a substantial proportion of disability discharges and compensation by the military services. Data presented to the AFEB in February 1990 indicated that over 50 percent of medical attrition (disability discharges) from each of the military services was due to orthopedic complaints (unpublished data, CAPT Taub, U.S. Navy). Across the Services that would translate to 10 to 15 thousand disability discharges due to orthopedic conditions each year. These data indicate that disabilities and hospitalizations resulting from nonfatal injuries have a significant effect on the health and combat readiness of military personnel.

d. The AFEB has also heard a number of presentations in the last several years that indicate that injuries treated on an outpatient basis also pose a significant problem for the Army and Marine Corps in particular. A number of the published reports have substantiated these presentations to the AFEB. Tomlinson et al reported average clinic visits rates for injury of 80 visits per 100 persons per year based on a sample of 15,295 soldiers stationed at a large Army post (Tomlinson, *Milit Med*, 1987). The rates of injury and limited duty are particularly high for infantry soldiers and military recruits (Jones, B.H. et al, *Am J Sports Med* 1993; Jones, B.H. et al, *Sports Medicine*, 1994; Knapik, J. *JOM*, 1993, Kowal, D. *Am J Sports Med*, 1980; Linenger, *Milit Med*, 1992; Shaffer, R, AFEB presentation 1994). For male Army trainees and infantry soldiers, reported rates of injury range from 10 to 15 per 100 person-months (Jones, B.H. et al, *Sports Medicine*, 1994). Data such as these clearly indicate that injuries can be expected to affect the health and performance of large numbers of soldiers every year. Some of these same studies have also identified modifiable risk factors for the most common types of injuries, those associated with physical training.

e. Several Army studies reported to the AFEB showed that injuries caused just as many outpatient clinic visits as all illnesses each year but resulted in 9 or 10 times as many days of limited duty (Jones, AFEB presentation 1991). Many of these injuries were conditions such as fractures, stress fractures, dislocations and severe sprains which are truly duty limiting (Jones, B.H. et al, *Med Sci Sports Excer*, 1993; Knapik, J. et al, *JOM*, 1993; Reynolds, *AM J Prev Med*, 1994; Tomlinson, *Milit Med*, 1987). Among infantry soldiers rates of limited duty ranging from 50 to 100 days of restricted activity per 100 person-months have been documented (Knapik, J. et al, *JOM*, 1993; Reynolds, K. et al, *J Prev Med*, 1994). Although little information is available on injuries treated in outpatient clinics for the Air Force, Navy or Marines, if the limited duty rates for these branches approach those of the Army then the manpower losses are large.

f. Although this summary of presentations to the AFEB and the literature on injuries has not been exhaustive, it gives an impression of the fragmentary nature of the information on injuries in the military services. Nevertheless, the available data provided the AFEB with several key insights. These insights were:

- (1) Injuries pose a significant problem for each of the services.
- (2) Administrative databases with potential for routine medical surveillance exist for all of the Services.
- (3) Research by the Army and Navy has identified risk factors from which to develop prevention strategies for some of the most common injuries.

The AFEB was persuaded to focus on injuries by the critical mass of information indicating that injuries were not only a significant threat to the health of military personnel but also by indicators that progress towards even more effective injury prevention is possible.

Section III. Injuries During Wars and Armed Conflicts

a. Although the AFEB did not concentrate attention on combat casualties, it is recognized that such casualties are of great concern to military commanders. Casualties occurring during combat have an immediate and direct impact on the accomplishment of military missions and, therefore, a brief discussion of the impact of injuries on combat readiness is warranted.

b. The military medical literature indicates that during wars and conflicts, nonbattle injuries result in substantial manpower losses. In World War II (WWII), nonbattle injury fatality rates were more than 3.5 times higher than those for all diseases (2.2 per 1000 man-years versus 0.6, Garfield et al, JAMA, 1990). However, battle wounds killed about 4.5 times as many service personnel as nonbattle injuries (10.1 battle deaths per 1000 man-years versus 2.2 nonbattle injuries). As with peacetime, fatalities during wars provide only a limited measure of the effect of injuries and other medical conditions on the health of military personnel.

c. Hospitalizations provide a better indicator of the impact of nonbattle injuries on fighting strength. Table 1 displays data on the distribution of hospital admissions for Army personnel engaged in wars and conflicts since WWII.

Table 1. Percent of Army Hospital Admissions due to Injuries and Disease in Wars and Conflicts from World War II to Operation Desert Shield/Storm in Southwest Asia (SWA)

	WW II ¹	Korea ¹	Vietnam ¹	SWA ²
	1942-1945	1950-1953	1965-1969	1990-1991
Battle Injury	4%	23%	17%	4%
Nonbattle Injury	11%	16%	14%	24%
Disease Complaints	85%	61%	69%	72%
Total Percent	100%	100%	100%	100%
Admission Rates	697 per 1000 mn-yr	1005 per 1000 mn-yr	505 per 1000 mn-yr	159 per 1000 mn-yr

1. Neel, Spurgeon. Medical Support of the U.S. Army in Vietnam 1965 to 1970. Department of the Army, U.S. Government Printing Office, Washington, D.C., 1973

2. Unpublished data, see Section 5: Deployment Surveillance.

d. Diseases in general have been the leading reason for hospitalization of soldiers during combat, from WWII to the present, while nonbattle injuries have accounted for nearly the same numbers of hospitalizations as battle injuries, with the exception of SWA (Table 1). This crude categorization of combat casualties into diseases and battle and nonbattle injuries, may not adequately portray the importance of nonbattle injuries.

e. More refined categorization of data on hospitalizations of marines during the Vietnam conflict (Palinkas and Coben, *Milit Med*, 1988) suggest that the relative importance of nonbattle injuries may be even greater than previously recognized. When the data are tabulated by more precise diagnostic groups from the International Classification of Diseases (the 9th Revision) as seen in Table 2, accidents and injuries are the leading category of hospitalization. The injury code group accounted for 21 percent of hospitalizations among marines from 1965 to 1970 compared to the second code group, infectious diseases, which caused 17 percent of hospitalizations followed by diseases of the skin at 8 percent. The fourth leading category of hospitalization for marines was musculoskeletal and connective tissue disorders that accounted for 8 percent of hospital admissions among marines in Vietnam. Many of the conditions in this musculoskeletal condition code group are actually the recurrent, chronic or late effects of injury. Therefore, in Vietnam, almost 30 percent of hospitalized marine casualties may actually have been the result of injury-related conditions.

f. This same study of Marine Corps casualties in Vietnam showed that Marines stationed in Vietnam were 2.5 times more likely to be hospitalized for nonbattle injuries compared to contemporaries not stationed in Vietnam, and 2.2 times more likely to be hospitalized for musculoskeletal conditions (Palinkas and Coben, *Milit Med* 1988). Thus, nonbattle injuries may be even more important during combat than during peacetime operations and training.

g. Virtually all of the available information on combat casualties is either for fatalities or hospitalizations. Until recently, there has been no information on rates or relative frequency of injuries or other medical conditions treated in battalion aid stations or similar outpatient type settings during combat. This makes it difficult to assess the full impact of injuries on combat missions. The paucity of data on non-fatal, non-hospitalized casualties during combat should not be a surprise, however, since it is also not available during peacetime training and operations. It is difficult to imagine being able to field functional surveillance systems or prevention programs in combat if they are not working during peacetime.

Table 2. Hospitalization of Marines during the Vietnam War by Combat Status and Principle Diagnostic Group, 1965 to 1970 ¹.

		Vietnam			Non-Vietnam	
Diagnostic Category	Rank	Number	Rate/ 1000 py-yrs	Rank	Number	Rate/ 1000 py-yrs
Injuries/ Accidents	1	39,896	117	1	58,530	47
Infections	2	31,777	93	7	17,465	14
Ill-Defined	3	22,997	67	8	14,852	12
Skin	4	16,113	47	5	19,405	16
Musculoskeletal	5	14,855	44	4	24,319	20
Nervous System	6	12,794	38	9	12,852	10
Mental	7	12,046	35	3	24,863	20
Digestive	8	11,256	33	6	19,375	16
Respiratory	9	8,813	26	2	43,574	35
Special	10	6,092	18	12	6,582	5
Urinary	11	5,889	18	10	9,855	8
Circulatory	12	3,740	11	11	8,860	7
Neoplasms	13	2,226	7	14	4,510	4
Blood	14	1,595	5	16	1,310	1
Endocrine	15	1,258	4	15	2,765	2
Congenital	16	1,307	4	13	5,026	4
Total	---	192,654	565	---	274,125	221
Population at Risk	---	341,176	---	---	1,241,649	---

1. Adapted from Palinkas and Cohen, *Military Medicine*, 1988.

h. Given that over 75 percent of documented nonfatal casualties during wars and conflicts since WWII have been the result of disease and nonbattle injuries, development of good medical surveillance systems should be a matter of concern not only for the service medical departments but also line commanders. Just as intelligence regarding the human enemy is critical to accomplishment of combat missions medical surveillance is essential to protect military personnel against the threats of injury and disease. Development of simple, yet effective, information systems to monitor and track the rates of injuries and disease treated at all care levels should be a top military priority. Rapid feedback from such systems could provide commanders with information necessary to maximize the health and performance of personnel in combat, as well as during peacetime.

i. If the recommendations of the AFEB result in more effective medical surveillance and injury prevention capabilities, the systems developed will influence both peacetime and combat readiness and operations of the military services. Development of peacetime surveillance systems will provide the experience and practice necessary to respond in combat.

Section IV. AFEB Historical Interest in Injuries

a. Although, historically, the AFEB has most commonly provided the Military services with recommendations on the control of infectious diseases, it has also demonstrated a keen interest in injury epidemiology and prevention. A brief description of the AFEB's past interest not only illustrates the extent of its involvement in injury prevention but also provides a context in which to understand its possible influence.

b. In 1951, at the request of the Army Office of The Surgeon General (OTSG) the AFEB established a Commission on Accidental Trauma. In a published report in 1962 (Mc Farland, *Milit Med*, 1962) the commission noted that fatality rates from disease in the U.S. Army (the Service for which the best records were available) had fallen drastically between 1820 and 1953, from about 3,500 per 100,000 man-years to less than 25 per 100,000 man-years. The Commission report made a strong point that during this same period, injury fatality rates had not decreased and continued to hover between 100 to 150 deaths per 100,000 man-years. The Commission further noted that injury fatality rates in recent years had been three to five times higher than disease rates. The report also documented that among military personnel over 2 and 1/3 million man-days were lost due to accidents in 1957 alone. The number of fatalities due to different causes for each Service (Army, Navy and Marines, and Air Force) were enumerated in the report and showed that privately operated motor vehicles accounted for more than twice as many fatalities as any other single cause.

c. At the time of the 1962 report, motor vehicle crashes also accounted for more lost man-days from duty than any other cause for the military services with the exception of the Army. In the Army "industrial accidents" and "sports and recreational activities" resulted in the greatest amount of lost duty time. In order to establish research priorities, the Commission constructed a list of the most important causes of accidents for the Armed Services as a whole "based on total number of deaths, loss in manpower, and monetary costs." The relative importance of different causes of accidents in the Armed Services determined by the AFEB in descending order was:

- (1) Private motor vehicle accidents
- (2) Aircraft accidents
- (3) Sports accidents
- (4) Weapons handling
- (5) Machinery (industrial) accidents
- (6) Ship Accidents
- (7) Military motor vehicle accidents
- (8) Other land transport accidents
- (9) Fire and explosion accidents
- (10) Exposure to weather
- (11) Parachuting accidents
- (12) Natural disasters

As a consequence of this prioritization, much of the research sponsored by the AFEB focused on causes and prevention of motor vehicle crashes. However, the Commission also devoted a great deal of energy to development of "quantitative methods for analyzing causative factors in accidents and their control" and determining whether the epidemiological approach which had been successfully used for the study and prevention of infectious disease "could be applied effectively to the analysis and control of injuries and fatalities."

d. In its report (McFarland, Milit Med, 1962) the Commission concluded that:

- (1) "The epidemiologic method was appropriate for the study of accidents
- (2) That physicians in the military services should be more active in accident prevention measures
- (3) That effective liaison could be maintained with line and safety officers."

Today these findings of the commission in 1962 are equally germane to injury research, prevention and control by the military services.

e. Much progress in the prevention of injuries can be documented since the Commission on Accidental Trauma Report was published in 1962. Overall accidental injury fatality rates have declined by over 50 percent to less than 50 per 100,000 person-years (DIOR, Worldwide Casualty Report, 1994), and motor vehicle- and aviation-related fatalities have decreased drastically (Unpublished Service Safety Center/Agency data). Motor vehicle fatality rates for the Army have declined from 40 per 100,00 person years in the early 1980s to 20 per 100,000 in the early 90s (unpublished Army Safety Center data, 1994). Despite tremendous success in preventing fatal injuries, the epidemic of disabling and time loss injuries continues to effect the health and readiness of military personnel.

Section V. AFEB Current Interest in Injuries

a. Over the last 5 years the AFEB has demonstrated renewed interest in injuries. During that period, the AFEB has heard a number of briefings on injuries from representatives of the Army, Navy and Air Force. Data for these reports have been derived from a variety of sources - Casualty Office data on deaths, Service Safety Center accident surveillance, medical evaluation board results, hospitalization records, and medical research. Data from different sources has been reported with varying degrees of epidemiologic sophistication ranging from simple frequencies and percents of injuries to rates and multivariate analysis of risk factors for injury. Regardless of the source of the data and of the complexity of the analytical methods applied, the conclusions have been the same - injuries are the leading health problem of the military services.

b. In October 1991, the AFEB was briefed on a concept for a program of comprehensive, integrated injury control for the military services. This same briefing was presented to the DOD Safety and Occupational Health Policy Council later in October 1991. As a result of that briefing the Deputy Assistant Secretary of Defense for the Environment (Mr. Baca) formed the DOD Injury Surveillance and Prevention Work Group in September of 1992. That Work Group now operates under the auspices of the Directorate of Safety and Occupational Health Policy, in the Office of the Assistant Deputy Under Secretary of Defense for Safety & Occupational Health. The DOD Injury Surveillance and Prevention Work Group is composed of military safety and medical personnel and has been systematically conducting an inventory of the content and capabilities of databases maintained by the military services that contain information on injuries.

c. In January 1994, because of mounting evidence that injuries were a major threat to the health and readiness of the Army, the OTSG of the Army requested the AFEB's "guidance and recommendations on surveillance, prevention and control of injuries in military populations...". In order to assist in making a decision, the AFEB requested presentations on the problem of injuries from each of the services at its meeting in February 1994. The AFEB was convinced by those and previous briefings that injuries were not only a significant problem for all the services, but that the infrastructure already existed to make rapid progress towards more effective prevention of injuries, in particular nonfatal injuries. As a consequence of those convictions, the AFEB formed an Injury Prevention and Control Work Group (AFEB Memorandum, 9 March 1994) under the auspices of the Assistant Secretary of Defense for Health Affairs. The AFEB Work Group is composed of civilian epidemiologists, physicians and other scientists with liaison members from each of the military services.

d. In order to better understand the nature and magnitude of the problem with injuries and the potential sources of surveillance data, the AFEB Injury Work Group reviewed data and research on injuries from a variety of sources for each of the services at its first two meetings in December 1994 and February 1995. After those initial meetings, the Work Group felt that the data presented to them was so compelling that an immediate report was warranted.

e. The Work Group decided that their efforts would be of greatest benefit to the military services if they concentrated on medically-related databases which are not routinely used for injury surveillance. For this reason, the Work Group did not evaluate the Safety Center surveillance systems. The Work Group felt that it would be of most value to evaluate databases that are:

- (1) Capable of tracking rates and trends of injuries.
- (2) Able to determine the relative importance of injuries compared to other medical conditions.
- (3) Not currently used for injury surveillance.

Section VI. Injury Work Group Objectives and Report Purposes

a. This report on injuries in the Military grew out of the efforts of the two DOD Injury Work Groups discussed above - the AFEB Injury Prevention and Control Work Group and the ADUSD (Safety & Occupational Health) DOD Injury Surveillance and

Prevention Work Group. This report was written by members of the AFEB Work Group and represents the priorities, opinions and interpretations of that Work Group but it relies heavily on data gathered by the DOD Injury Surveillance and Prevention Work Group.

b. The AFEB Injury Prevention and Control Work Group reviewed data on deaths, disabilities, hospitalizations and outpatient care for all the services. It also examined information from surveillance during recent conflicts in SWA and Somalia. At the onset of its review of injury and other medical data, the AFEB Work Group's objectives were to:

(1) Determine the magnitude of the problem with injuries relative to other causes of morbidity and mortality for each of the services.

(2) Identify important types and causes of injuries to guide medical research and prevention programs.

(3) Provide recommendations for injury prevention strategies and programs.

(4) Evaluate the surveillance potential of the medically-related administrative databases maintained by the services.

(5) Determine what further information is needed to evaluate the usefulness of the potential surveillance databases.

(6) Make recommendations for the more effective use of existing automated administrative databases (deaths, disabilities and hospitalizations).

(7) Make recommendations for development of outpatient and deployment (combat) surveillance systems.

This report summarizes the data on the health of active duty military personnel which the Work Group evaluated. The conclusions and recommendations derived from the Work Groups review are discussed at the end of each section on the different databases and are further summarized in the appendix.

c. The purposes of the report are to:

(1) Appraise the AFEB, the Assistant Secretary of Defense for Health Affairs, and the medical departments of the military services, of the full magnitude of the

problem with injuries relative to other medical conditions impacting the health and readiness of the Armed Forces.

(2) To draw attention to the potential value of existing databases for injury and medical surveillance.

(3) To lay the foundation for future medical department contributions to prevention and control of the leading health problem of the U.S. Military - injuries.

COL Bruce H. Jones, MC
Co-Chairman

Dr. Barbara C. Hansen
Co-Chairman

References

1. Directorate of Information and Operations Reports, Washington Headquarters Service, Department of Defense. *Worldwide U.S. Active Duty Military Personnel Casualties: October 1979 through March 1994*. U.S. Government Printing Office, Washington, D.C., 1994.
2. Garfield, R. N., A. I. Nengut. *Epidemiologic Analysis of Warfare*. JAMA. 266(5): 688-692, 1991.
3. Helmkamp, J. C. *A Descriptive Summary of Active-Duty Deaths in the U.S. Navy in 1986*. Milit Med. 153: 621-625, 1988.
4. Jones, B. H., M. W. Bovee, J. M. Harris, D. N. Cowan. *Intrinsic Risk Factors for Exercise-related Injuries among Male and Female Army Trainees*. Am J Sports Med. 21(5): 705-710, 1993.
5. Jones, B. H. *Exercise, Training, and Injuries*. Sports Medicine. 18(3): 202-214, 1994.
6. Jones, B. H., D. N. Cowan, J. P. Tomlinson, J. R. Robinson, D. W. Polly, P. N. Frykman. *Epidemiology of Injuries Associated with Physical Training Among Young Men in the Army*. Med. Sci. Sports Exerc. 25(2): 197-203, 1993.
7. Knapik, J. J., P. Ang, K. L. Reynolds, B. H. Jones. *Physical Fitness, Age, and Injury Incidence in Infantry Soldiers*. JOM. 35(6): 598-603, 1993.
8. Kowal, D., *Nature and Causes of Injury in Women Resulting from an Endurance Training Program*, Am J Sports Med. 8: 265-269, 1980.
9. Linenger, J. M. *Epidemiology of Soft-Tissue/ Musculoskeletal Injury Among U.S. Marine Recruits Undergoing Basic Training*. Milit Med. 157: 491-493, 1992.
10. McFarland, R.A. Armed Forces Epidemiological Board: *Research on Accidental Trauma in the Armed Service, A Summary of the Research Program of the Commission on Accidental Trauma*. Milit Med. 127(8): 615-629, 1962.
11. National Academy of Sciences, *Injury in America*. National Academy Press, Washington, D.C., 1985.

12. Neel, S. *Medical Support of the U.S. Army in Vietnam 1965 to 1970*. Department of the Army, U.S. Government Printing Office, Washington D.C., 1973.
13. Palinkas, L.A., P. Coben. *Disease and Nonbattle Injuries among U.S. Marines in Vietnam*. *Milit Med*. 153: 150-155, 1988.
14. Reynolds, K. L., J. A. Pollard, H. A. Heckel, J. J. Knapik, C. E. Witt, B. H. Jones, J. W. Martin. *Cigarette Smoking, Physical Fitness, and Injuries in Infantry Soldiers*. *Am J Prev Med*. 10(3): 145-150, 1994.
15. Public Health Service. *International Classification of Diseases, 9th revision*. U.S. Government Printing Office, Washington, D.C., 1989.
16. Tomlinson, J. P., W. M. Lednar, J. D. Jackson. *Risk of Injury in Soldiers*. *Milit Med*. 152: 60-64, 1987.

CHAPTER 1

DEATHS DUE TO INJURY

Section 1-1. Introduction

a. More military personnel die of injuries each year than any other cause. Accidental (unintentional) injuries alone cause more than half of all deaths among military service members. These statistics are not surprising for a young, predominantly male, population which describes the military. Injuries also kill more young Americans, especially young males, than any other cause (Baker, Injury Fact Book, 1992; Gardner, NCHS Advance Report 1996; PHS, Health People 2000, 1991; NAS, Injury in America).

b. Deaths in the military are routinely recorded by the Service Casualty Offices and are reported to the Department of Defense Directorate of Information and Operations Reports (DIOR). The DIOR publishes a routine report, The Worldwide Casualty Report (DIOR, 1994), which tabulates the overall fatality rates for each Service and the frequency of deaths by five categories - accidents, illnesses, homicides, self-inflicted (suicides), and hostile action (combat). The published DIOR reports do not provide rates for the separate categories of death, and they do not further break down this data by age, gender, military occupation, more specific cause, or other possibly important factors. Dr. James Helmkamp, Commander, USN, (Retired), has used DIOR data and population data from the Defense Manpower Data Center to calculate the fatality rates of men and women in the military services for each of the five DIOR categories since 1980. This chapter of the AFEB Injury Prevention and Control Work Group report is derived primarily from Dr. Helmkamp's unpublished report, Deaths Among Active Duty Military Personnel, 1980-1992 (Helmkamp, J. 1994).

c. There are a number of other information sources on deaths in the military services. These sources include the Service Casualty Offices, the Service Medical Department hospital records systems, and the Safety Centers/Agencies of the Services. The Casualty Offices maintain administrative death records only on a specific service; the hospital records only capture data on deaths occurring or carded for record in military medical facilities; and the Safety Centers report only on deaths due to accidental causes. The DIOR data from Dr. Helmkamp was chosen as the basis for this chapter of the report because it is the only available source of data reporting rates for the full spectrum of fatal events among military personnel - unintentional (accidents) and intentional (homicide and suicide) injuries and diseases. It is also the most complete.

d. This section on deaths occurring in the military is intended to achieve three primary purposes:

- (1) To determine the magnitude of the problem with injuries in the military compared to other causes (illnesses/diseases).
- (2) To determine the relative importance of different categories of cause of injury deaths.
- (3) To provide some general recommendations regarding surveillance of injury fatalities.

Section 1-2. Proportion of Deaths Due to Injury

a. From 1980 through 1992, injuries (accidents, suicides, and homicides combined) accounted for 81 percent of all nonhostile deaths among active duty personnel in the Armed Services; illness accounted for 19 percent. Among the services, the proportion of deaths caused by injuries ranged from 78 percent in the Air Force to 90 percent in the Marines.

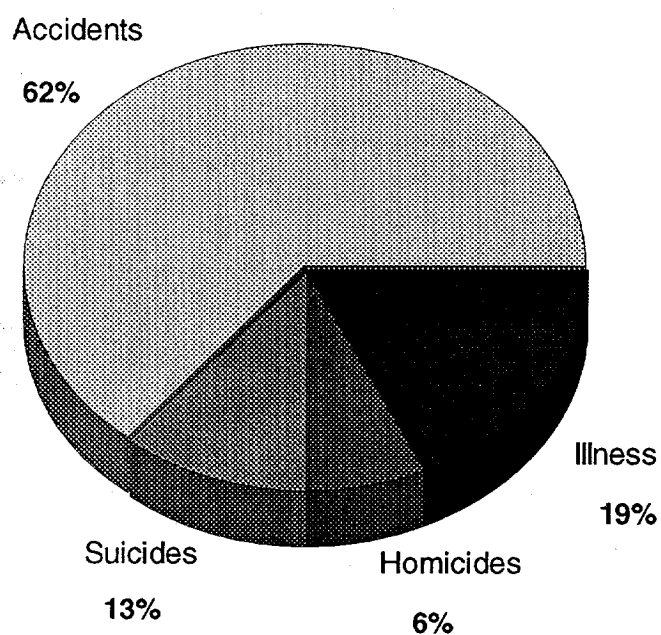
b. Accidents were the most common cause of death, accounting for 62 percent of nonhostile casualties (Figure 1-1). Accidents accounted for more than half the deaths in each service, ranging from 59 percent in the Air Force to 71 percent in the Marines (Figure 1-2). Overall, suicides accounted for 13 percent of the deaths, ranging from 12 percent each for the Army, Navy, and Marines, to 15 percent in the Air Force. Homicides accounted for 6 percent overall, ranging from 4 percent in the Air Force, to 7 percent in the Marines. See Addendum Tables 1A-1 to 1A-4, pp 1-13 to 1-16, for more specific causes of death from casualty office data.

Section 1-3. Rates of Deaths Due to Injury

a. From 1980 through 1992, the average death rate due to accidents was 62.3 per 100,000 persons per year. The suicide rate was 12.5, the homicide rate 5.0, and the death rate due to illness 18.4.

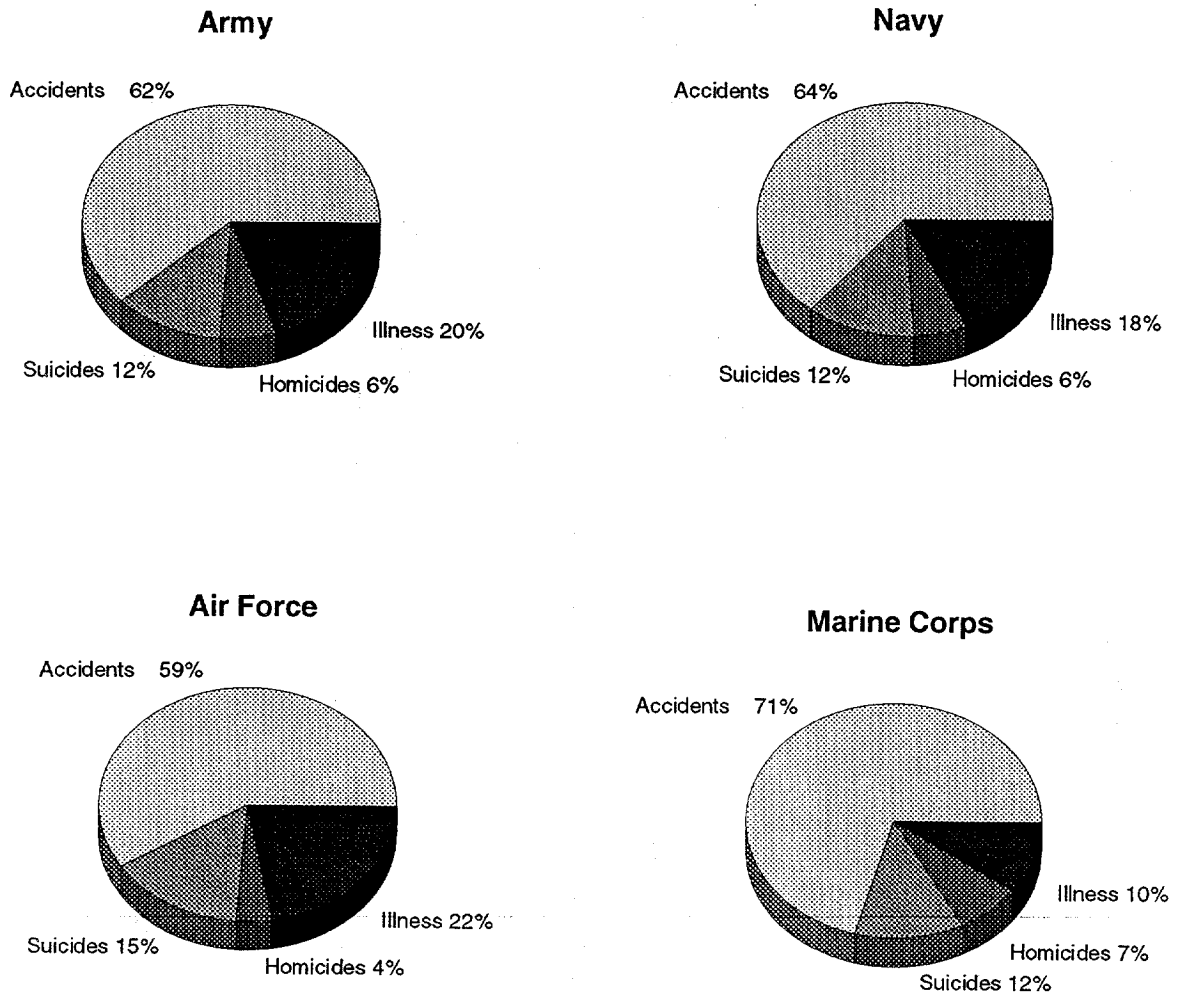
b. Among the services, the accidental death, homicide, and suicide rates were all highest for the Marine Corps (Figure 1-3). Accidental death and homicide rates were lowest for the Air Force. The Navy had the lowest suicide rate. The rate of accidental death ranged from 43.0 per 100,000 per year in the Air Force, to 79.1 in the Marines (Figure 1-3). The suicide rate ranged from 11.0 in the Navy to 13.7 in the Marines; and the homicide rate ranged from 2.6 in the Air Force to 7.4 in the Marines. Mortality due to illness was lower than for accidental injuries and ranged from 11.4 in the Marine Corps to 20.4 in the Army.

**Figure 1-1. Distribution of Nonhostile* Casualties
U.S. Armed Forces, 1980-1992 Combined**



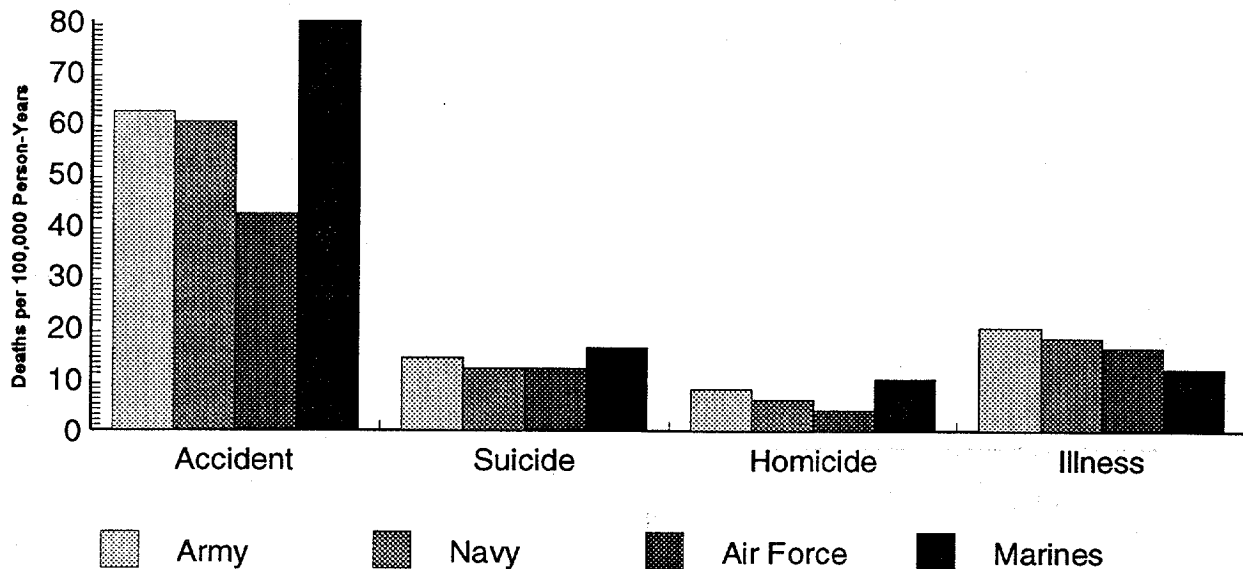
*Nonhostile includes Accidents, Suicides, Homicides, and Illness

**Figure 1-2. Distribution of Nonhostile* Casualties
U.S. Armed Forces, 1980-1992 Combined**



*Nonhostile includes accidents, suicides, homicides and illness.

**Figure 1-3. Mortality Rates in the Armed Forces
by Branch of Service, 1980-1992 Combined**



Section 1-4. Injury Death Rates Over Time

Sizeable reductions in the rate of nonhostile deaths occurred from 1980 through 1992, primarily due to declines in the death rates due to accidents (Figure 1-4). While fatality rates due to illness (disease) also decreased, the absolute magnitude of the decline was less and therefore had less impact on overall death rates. Suicide rates varied little over time. Homicide rates, on the other hand, declined gradually until 1989 then increased through 1992.

Section 1-5. Injury Rates by Gender

Overall, the death rate due to injury for males was about twice that for females (79.8 per 100,000 per year vs 36.1). The rate of accidental death for males exceeded that for females, 62.3 to 24.1; and the rate of suicide for males exceeded that for females, 12.5 to 5.5. In contrast, the rate of homicide for females exceeded that for males, 6.5 to 5.0 (Figure 1-5). The higher homicide rate for females compared to males is notably different from the general population, in which the homicide rate for males is about 4 times greater than for females.

Section 1-6. Mortality Sex Ratios

Table 1-1 displays the ratios of death rates for men compared to those for women (i.e., the mortality sex ratio) in each of the services and the services overall. The mortality sex ratios indicate that men in the services die from accidental causes at about 2.5 times the rate for women. The ratios also show that men die from self-inflicted injuries (suicides) and diseases (illnesses) at about twice the rate of women. An inverted ratio for homicide for men versus women was present in all four Services indicating that, unlike the civilian U.S. population, women in the military are murdered at a higher rate than men. The mortality sex ratios were similar across the four services, with the exception that the ratio for accidental death was noticeably higher for male versus female Marines than for the other three services and the ratio for suicide was noticeably higher for the Navy than the others.

Figure 1-4. Noncombat Mortality Rates

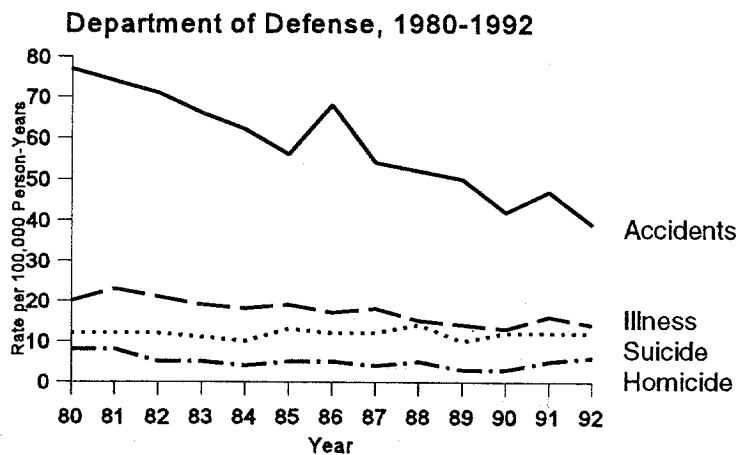


Figure 1-5. Mortality Rates by Gender

U.S. Armed Forces, 1980-1992 Combined

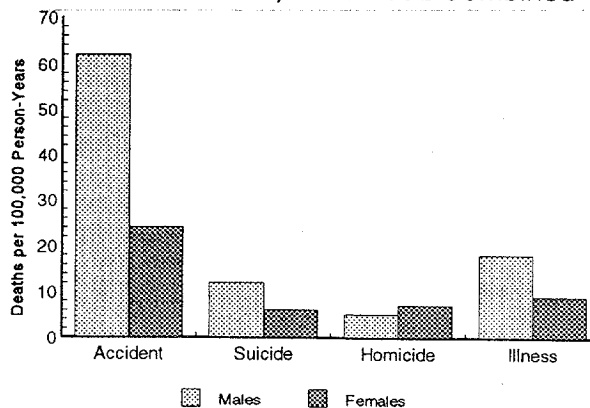


Table 1-1. Mortality Sex Ratio (Male:Female) by Service and Cause of Death, U.S. Armed Forces, 1980-1992.

Service	All Injuries	Accidents	Suicides	Homicides	Illnesses
All Services	2.2	2.6	2.3	0.8	2.1
Army	2.0	2.4	2.2	0.7	2.1
Navy	2.3	2.5	3.3	0.9	1.8
Air Force	2.1	2.4	2.0	0.6	2.4
Marines	2.5	3.6	1.8	0.6	1.7

Section 1-7. Conclusions

a. These data clearly demonstrate that injuries (accidents, homicides and suicides) are the most important cause of death among active duty members of the U.S. Armed Forces, accounting for about four out of five deaths. Accidents are the most common cause of nonhostile deaths and account for more than half of the fatalities in each of the four services. Reductions averaging about 4 percent per year in the rate of fatal accidents occurred between 1980 and 1992. The rates of accidental death, homicide and suicide are highest in the Marine Corps. The observation that the homicide rate is higher among active duty females than active duty males is in marked contrast to what is seen in the general population.

b. The downward trends in accidental injury fatalities indicate the type of success that can be achieved when attention is focused on preventing injuries. A study by Rothberg et al (JAMA 1990) showed that Army accident fatality rates were about the same as for civilian populations - another indicator of the success of military safety programs to prevent fatal injuries.

Section 1-8. Recommendations

a. Although fatality data of such a general nature as that presented from DIOR in this chapter has limited potential for use in developing specific prevention programs, several suggestions, nevertheless, seem appropriate. First, accidental injuries should continue to be a primary focus of safety and injury prevention programs, since this category of injuries continues to be the leading cause of injuries despite 15 years of successfully lowering rates.

b. Greater efforts to prevent intentional injuries (homicides and suicides) are warranted. Rates of homicides and suicides combined have not changed appreciably over the last decade and a half. Over this period of time, intentional injuries have on average accounted for almost 20 percent of all deaths but as accidental injury fatalities have decreased this percentage of the total has now risen to 25 percent or 30 percent of deaths in the military services (see addendum to this section on causes of injury deaths in 1994). Special attention should be given to preventing homicides among female service members in particular.

c. If rates of fatalities and disability due to injury are to be further reduced, valid, reliable, and complete data from military surveillance systems will be critical to provide the information necessary to identify which populations are at most risk, what the most important causes are, and how well strategies to prevent deaths are working.

d. To assist future efforts to prevent fatalities, the mortality information systems could be made more useful for prevention purposes by a few systematic modifications. Since the Casualty Offices of the Services maintain administrative personnel databases, recommendations for surveillance may need to be implemented at a separate cite, using not just casualty offices data, but also death certificates and hospital records. Some specific recommendations for surveillance follow.

(1) Tracking Trends. Rates of fatalities due to different causes and types of injuries and diseases should be reported routinely. The usual reports of frequencies are not adequate for tracking trends over time or between the services or other populations, especially in a downsizing environment. Therefore, there should be clear and consistent methods of determining denominators (i.e., the number of military personnel in the service populations at risk) for calculations of rates. This would assure accurate, consistent, and comparable calculations of rates over time, place, and service.

(2) Data Set Recommendations. Consistent information on the deaths themselves is also critical for surveillance and prevention of injuries. The Proceedings of the International Collaborative Effort (ICE) on Injury Statistics (NCHS, 1995) makes recommendations for the minimum basic data sets necessary for injury surveillance. These recommendations are intended to provide guidance on the minimum data necessary for development of prevention strategies and programs. The Work Group recommends that the Report of Casualty, DD Form 1300, Nov 91, be supplemented with more complete information about duty status, place, and type of casualty, specifically, to improve the potential usefulness of military casualty data for prevention.

(3) Duty status. Services should be required to report whether the member was on-duty, off-duty, on leave, in-patient, or other. It is the Work Group's understanding that presently, services are required to report whether the member was on active duty, active duty for training, or inactive duty training. It is their option to report on-duty, off-duty, on leave, in-patient, or other, but they do so inconsistently. What is most important is devising a means of determining whether an injury resulted from work, job, or training-related activity as opposed to leisure time activity.

(4) Place of injury. Services should provide information about the place where the fatal injury occurred. Presently, services provide information about where the member was pronounced dead. While these two locations (place of injury and place of pronouncement) may coincide, they frequently differ. Place of injury is much more important for prevention purposes than place of pronouncement. The new International Classification of Diseases, 10th Revision (ICD-10) has a thorough coding scheme for place of occurrence that could be adapted for military use. At the very least, services should report whether the injury was incurred on- or off-base.

(5) Type of injury. Services should report type of accident (e.g., motor vehicle collision, drowning) and method of homicide and suicide (e.g., firearm, cutting and stabbing instrument). These subcategories should be consistent with the ICD categories used for civilian vital statistics.

(6) Cause and Circumstance of Injury. Services should be encouraged to provide more information about the cause and circumstance of fatal injuries. Various coding schemes are available, such as the ICD-10. At the very least, services should be encouraged to provide more written descriptive information.

(7) Ownership and Type of Firearm. Services should be required to report the ownership and type of firearm used in any accidental death, suicide, or homicide. Ownership should indicate whether the weapon was military issue or privately obtained, and whether the weapon was the issue or property of the deceased, the perpetrator (for homicide), some other known person, or unknown. Firearms are the fatal weapon in 60 percent of suicides and 59 percent of homicides in the military.^{3,4}

(8) Standardization. Collection and coding of fatality data should be standardized across the Services.

The above are some of the most important recommendations of the work group. A further summary of recommendations, as well as conclusions, can be found in Appendix A.

e. The modifications recommended would greatly enhance the usefulness of the mortality data for the design, implementation, and evaluation of specific preventive measures. Reductions in motor vehicle fatalities, for example, have been brought about by more frequent use of seat belts, decreased tolerance for drunken driving, and improved design of vehicles and roads. These interventions derived, in large part, from the systematic review and analysis of routinely collected data. Similar gains are likely to be possible in other areas. The unique activities and data collection opportunities of the military create a situation in which important reductions in injuries can be accomplished.

f. Finally, information about nonfatal injuries should be routinely evaluated. This is very important because mortality data incompletely describe the burden of injuries upon military readiness. Nonfatal injuries are more common than fatal injuries and obviously influence the troops ability to function at full capacity. Some types of injuries, such as sports injuries, are common, frequently incapacitating, yet rarely fatal. The full impact of injuries upon military readiness requires information about both fatal and nonfatal injuries.

References

1. Baker, S.P., B. O'Neill, M.J. Ginsburg, G. Li. The Injury Fact Book. Oxford University Press, New York, NY, 1992, pp 8-10.
2. Directorate of Information and Operations Reports, Washington Headquarters Services, Department of Defense. Worldwide U.S. Active Duty Military Casualties Report. U.S. Government Printing Office, Washington, D.C. 20402
3. Gardner, P., B.L. Hudson. Advance report of final mortality statistics, 1993. Monthly vital statistics report; Vol 44, No. 7, supp., Hyattsville, Maryland, National Center for Health Statistics, 1996.
4. Helmkamp J.C. Suicide in the Military: 1980-1992. *Milit Med* 1995; 160: 45-50.
5. Helmkamp J.C. Homicide Victims in the Military: 1980-1992. *Milit Med* 1995; 160:50-56.
6. National Academy of Sciences. Injury in America: A continuing Public Health Problem. National Academy Press, Washington, D.C., 1985, pp 3-6.

7. Public Health Service. Healthy People 2000: National Health Promotion and Disease Objectives. U.S. Government Printing Office, Washington, D.C., DHHS Publication No. (PHS) 91-50212, 1991.

8. Rothberg, J.M., P.T. Bartone, H.C. Holloway, D.H. Marlowe. Life and Death in the U.S. Army. JAMA, 1990; 264:2241-2244.

ADDENDUM TO SECTION I. DEATHS DUE TO INJURY CAUSES OF INJURY DEATHS IN 1994

Tables 1A-1, 1A-2, 1A-3 and 1A-4 in this addendum display the leading causes of death for the Army, Air Force, Navy and Marine Corps, respectively in 1994. With the possible exception of the Air Force, motor vehicle crashes (both private and military/government owned vehicles) are the leading cause of deaths for the military services. Motor vehicle (POV, plus MOV/GOV) crashes account for between 30 and 40 percent of fatalities among military personnel. For the Army, Navy and Marine Corps, gunshot wounds from homicide, suicide and accidents are the second leading cause of deaths resulting in about 20 percent of all deaths in these services. Heart attacks, the leading cause of deaths due to disease, cause 6 percent to 13 percent of all fatalities in the different services. Other important causes of injury deaths vary from service to service but include aviation accidents, drownings, and falls.

**Table 1A-1. Causes of Death Among Active Duty U.S. Army Personnel
1994 (Excludes Deaths Due to Hostile Action)**

Cause of Death	# of Deaths	% of Total Deaths
Vehicle Accident	149	31.5
Gunshot	98	20.7
Heart Attack	45	9.5
Fire/ Burns	25	5.3
Training Related	24	5.1
Drowning	13	2.7
Friendly Fire	13	2.7
Hanging	11	2.3
Aircraft/ land	11	2.3
Stabbing	10	2.1
Fall or Jump	7	1.5
Unknown	6	1.3
Cancer	5	1.1
Strangulation	5	1.1
Respiratory failure	3	.6
Suffocation	3	.6
Pneumonia	2	.4
Stroke	2	.4
Explosive device	2	.4
Artillery round	1	.2
Parachute accident	1	.2
Misadventure	1	.2
Other	20	4.2
TOTAL	473	100

Facsimile Transmission Document 7/95. Source; Army Casualty Information Processing System.

**Table 1A-2. Causes of Death Among Active Duty U.S. Air Force Personnel
1994 (Excludes Deaths Due to Hostile Action)**

Cause of Death	# of Deaths	% of Total Deaths
Suicide	67	29.5
POV ¹ Auto	53	23.3
Heart Attack	27	11.9
GOV ² - Aircraft	20	8.8
Other- Illness	11	4.8
POV Motor Cycle	12	5.3
Homicide	9	4.0
Ground- Drowning	5	2.2
POV- Other	3	1.3
Ground- Fall	2	0.9
Cancer	2	0.9
POV- Pedestrian	2	0.9
POV- Aircraft	2	0.9
GOV- Auto	1	0.4
Others	11	4.8
TOTAL	227	100

Facsimile Transmission Document 7/95. Source U.S. Air Force (AL/AOP).

¹POV = Privately Owned Vehicle

²GOV = Government Owned Vehicle

Table 1A-3. Causes of Death Among Active Duty U.S. Navy Personnel - 1994
(Excludes Deaths Due to Hostile Action)

Casualty Manner/ Cause	Number of Deaths	% of Total Deaths	% of Category
ACCIDENTS			
Vehicle loss or accident	87	31.6	64.4
Drowning	9	3.3	6.8
Aircraft/ sea	9	3.3	6.8
Aircraft/ land	5	1.8	3.7
Fall or jump	4	1.5	3.0
Fell or lost overboard	2	.7	1.5
Suffocation	2	.7	1.5
Hanging	2	.7	1.5
Gunshot or small arms fire	1	.4	.7
Parachute	1	.4	.7
Electrocution	1	.4	.7
Alcohol abuse or overdose	1	.4	.7
Strangulation	1	.4	.7
Other	10	3.6	7.4
Sub-total	135	49.1	100
ILLNESS			
Heart attack	33	12.0	66.0
Cancer	7	2.5	14.0
Stroke or CVA	2	.7	4.0
Respiratory failure	1	.4	2.0
Cause not reported	1	.4	2.0
Other	6	2.2	12.0
Sub-total	50	18.2	100
HOMICIDE			
Gunshot or small firearm	12	4.4	70.6
Stabbing	2	.7	11.8
Strangulation	1	.4	5.9
Beating	1	.4	5.9
Other	1	.4	5.9
Sub-total	17	6.2	100
SELF-INFLICTED			
Gunshot or small firearm	41	14.9	74.6
Hanging	6	2.2	10.9
Poisoning (carbon monoxide)	3	1.1	5.5
Fall or jump	1	.4	1.8
Drowning	1	.4	1.8
Stabbing	1	.4	1.8
Drug abuse or overdose	1	.4	1.8
Other	1	.4	1.8
Sub-total	55	20.0	100
UNDETERMINED	18	6.5	100
TOTAL	275	100	

Source; Worldwide Casualty System Database

Table 1A-4. Causes of Death Among Active Duty U.S. Marine Corps Personnel - 1994
(Excludes Deaths Due to Hostile Action)

Casualty Manner/Cause	# of Deaths	% of Total Deaths	% of Category
ACCIDENT			
Vehicle loss or accident	53	41.4	69.7
Aircraft /land	7	5.5	9.2
Drowning	5	3.9	6.6
Gunshot or small arms fire	4	3.1	5.3
Other explosive device	2	1.6	2.6
Other	2	1.6	2.6
Electrocution	1	.8	1.3
Parachute	1	.8	1.3
Fell or lost overboard	1	.8	1.3
Sub-total	76	59.5	100
ILLNESS			
Heart attack	8	6.3	61.5
Cancer	2	1.6	15.4
Other	2	1.6	15.4
Pneumonia	1	.8	7.7
Sub-total	13	10.3	100
HOMICIDE			
Gunshot or small fire arm	5	3.9	55.6
Stabbing	2	1.6	22.2
Beating	2	1.6	22.2
Sub-total	9	7.1	100
SUICIDE			
Gunshot or small fire arm	17	13.3	81.0
Fall or jump	1	.8	4.8
Drug abuse or overdose	1	.8	4.8
Poisoning (carbon monoxide)	1	.8	4.8
Hanging	1	.8	4.8
Sub-total	21	16.5	100
UNDETERMINED	9	7.0	100
TOTAL	128	100	

Source; Worldwide Casualty System Database.

CHAPTER 2

DISABILITIES DUE TO INJURY

Section 2-1. Introduction

a. Injuries and their impact may be evaluated from a number of perspectives; one of which is the disability associated with injuries. Disability is a broad-based concept. Unlike most clinical measures associated with injuries, though, the definition of disability as it applies to persons with injuries is multidimensional. The influence of disability may be permanent or temporary. It may affect the ability to maintain active duty status or the ability to enjoy off-duty activities.

b. Disability data pertaining to members of the Armed Forces are compiled routinely through a number of sources. For example, information is available on the number of days lost to duty from short-term medical or health conditions through the medical branches of the services. In addition, a distinct agency within each service maintains records that document disabilities of a more severe and potentially long-term nature.

c. The Physical Disability Agency in the Army, the Physical Disability Division in the Air Force, and the Disability Evaluation Board in the Navy all consider cases where an individual sustains a substantial injury or disease while on active duty and may be eligible for some form of compensation. These disability agencies or, more precisely, the Physical Evaluation Boards (PEBs) within each service, have the general purpose of determining an individuals' fitness for continued active service and removing, from active duty, personnel who can no longer perform their duties because of physical disability. Compensation decisions are rendered for individuals where a disability is incurred or aggravated while in receipt of basic pay, or for career members of the service who are unable to complete their careers due to a physical disability. The PEBs generally consider information from the respective medical evaluation boards (MEBs) and line of duty (LOD) determination reports in arriving at their decisions.

d. The automation and use of disability records for injury surveillance purposes is sporadic throughout the three services. The Air Force Physical Disability Division maintains a database of their disability files. This database contains MEB, LOD, and PEB data but does not record race, gender, or the age of affected individuals. Interpretation of the LOD data also is hindered by inconsistencies, with the information being collected in different formats over the years. The Navy maintains a computerized database on both PEB and MEB reviews and recommendations. The Army, at this time, maintains a computerized listing of cases reviewed by PEBs for the Physical Disability Agency but not for MEBs.

e. A tri-service disability information system has been proposed. In December 1993, the Deputy Assistant of Defense (Military Manpower and Personnel Policy) chartered a tri-service work group led by Office of the Assistant Secretary of Defense (Health Affairs) to study the development of an automated system to provide the capability to examine PEB and MEB case files. The current status of this proposal is not clear, but such an automated system across the three services could provide a valuable tool to identifying the role of injuries in long-term disability and the costs associated with them.

f. The disability systems described above apply to active military personnel. The Veterans Administration (VA) also manages a disability compensation system. The VA system examines situations pertaining to individuals outside of the services, who are seeking compensation for service-related disabilities.

g. The economic impact of disability in the military is substantial. In 1990, the costs of compensation for permanent and temporary disability was nearly \$1.5 billion for the three services (Table 2-1). The lifetime costs of new disabilities compensated by the Army in 1993 have been estimated to be \$485 million. Clearly, both are significant levels of compensation provided by the services. These are moneys that are debited directly out of each military department's annual budget. Thus, if injuries are a major contributory cause to these events, then directed prevention programs have the opportunity to save large sums of money for each of the services.

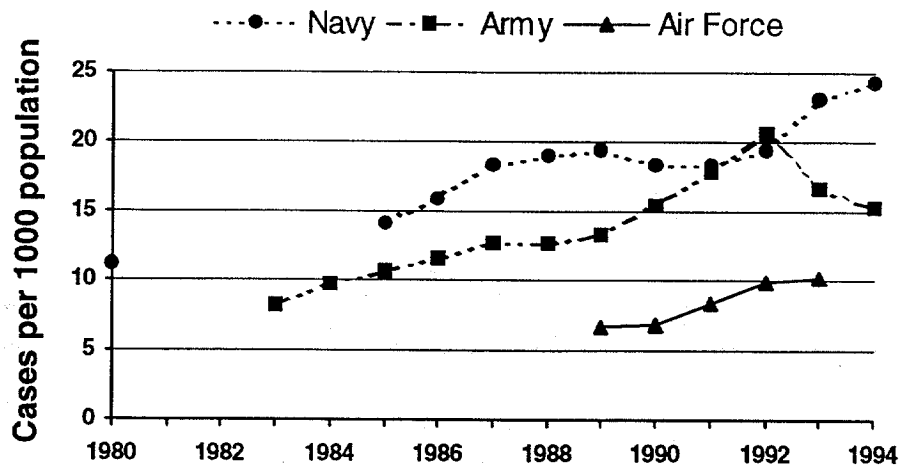
Table 2-1. Costs of Compensation for Permanent and Temporary Disability in the Three Services, 1990

	<u>Total Number Affected</u>	<u>Total Costs (1990 \$)</u>
PDRL (permanently retired)	122,744	1,373,022,000
TDRL (temporary retired list)	11,393	<u>91,561,000</u>
		1,464,593,000

Section 2-2. Magnitude of the Problem

a. What is the importance of injuries in the military with respect to long-term disability, compensation, and fitness for active duty? The answer to this question is not entirely clear at this time. Figure 2-1 presents information on the number of cases reviewed by the PEBs in each service within the last 15 years adjusted by the total population of each respective service.

Figure 2-1: Disability Cases Reviewed by PEBs

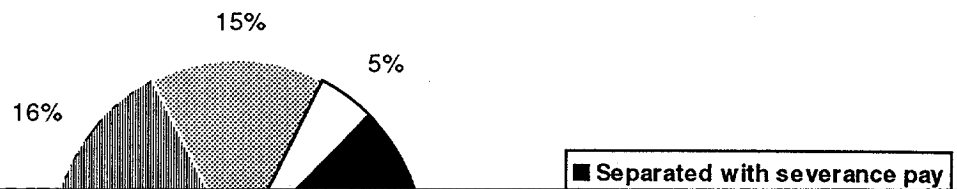


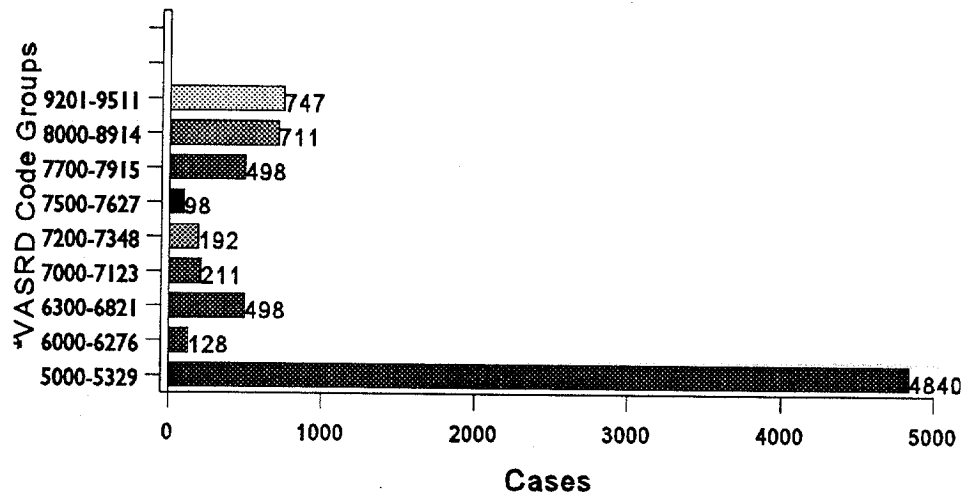
b. As is apparent from the graph, there has been a general increase in the number of disability cases reviewed by PEBs over the last 10 years. Recent data from the Army, however, suggests that the rate of disability may have decreased in 1993 and 1994. These data include reviews of both active duty personnel and temporary disability retired list (TDRL) personnel. As such, the data may not reflect entirely new cases of disability within each year. Also, the data may be influenced by changes in the definition of eligibility for PEB review over time.

c. The information presented above portrays the overall extent of disability cases reviewed by PEBs. Other types of data, though, are equally useful for evaluating the impact of disability. These include data on the level of severity of disability, and the demographic characteristics of personnel coming before PEBs (e.g., age, gender, rank).

d. Figure 2-2 presents an example of what level of severity may be involved with the cases under review. Of 6,235 cases reviewed by the Army PEB in the first 9 months of FY 94, the majority (59 percent) were discharged from service. Twenty-six percent were found fit for duty, and 15 percent were placed in the TDRL category. Thus, the PEBs, in all likelihood, are reviewing a high proportion of cases with serious concerns about their ability to serve in active duty. Once someone comes up to the PEB, there is a high probability that they will be discharged from the services. Seventy-four percent receive compensation or are discharged or both.

**Figure 2-2. Disposition of Cases Reviewed by Army PEB
(FY1994 first 9 months)**



ADDENDUM TO CHAPTER 2: DISABILITY DUE TO INJURY**Navy Physical Evaluation Board Data MID-FY 95**

- 9201-9511 Mental Disorders (10%)
- 8000-8914 Neurological Conditions/Convulsive Disorders (9%)
- 7700-7915 Heme + Lymphatic Systems, Skin, Endocrine System (4%)
- 7500-7627 Genitourinary/Gynecological Conditions (1%)
- 7200-7348 Digestive System (3%)
- 7000-7123 Cardiovascular System (3%)
- 6300-6821 Systemic Conditions/Respiratory System (6%)
- 6000-6276 Visual and Auditory Conditions (2%)
- 5000-5329 Orthopedic and Musculoskeletal System Conditions (63%)

*VASRD: Veteran's Administration Schedule of Ratings of Disabilities

CHAPTER 3

HOSPITALIZATION DUE TO INJURIES

Section 3-1. Introduction

a. While injury fatalities are an important problem, hospitalized injuries occur in much larger numbers and often result in long-term disability. The largest health impact on military populations in terms of hospitalization is injuries. Hospitalized injuries also result in the largest direct costs of medical care. Being the most serious of the nonfatal injuries, they also result in the most lost work days, include the largest proportion of disabling injuries, and have the largest impact on troop readiness. For the U.S. as a whole, hospitalized injuries are the most expensive group of injuries (based on severity), they incur the highest total (direct and indirect) lifetime costs (\$80.1 billion in 1985), being almost twice the costs of fatal injuries (\$49.4 billion) and almost three times the costs of nonhospitalized injuries (\$28.2 billion) [Rice 1989]. Among persons ages 15-44 (the age group comparable to most service personnel), hospitalized injuries result in the most costs of any group. While similar cost data are not yet available for the military, hospitalized injuries clearly represent a major health problem and should be given high priority for prevention purposes.

b. Data from Desert Storm suggest that accidents (unintentional injuries), other acute injuries, and musculoskeletal conditions accounted for 43 percent of all hospitalizations during the operation, but only a small proportion of hospitalized injuries were due to combat (Writer, 1995). Thus, injury hospitalizations are an important cause of loss of readiness in military personnel. In addition, 14 percent of hospitalizations were due to musculoskeletal and connective tissue disorders (code group 710-739), many of which were the chronic or recurrent effects of injuries that occurred before deployment.

Section 3-2. Magnitude of the Problem

a. Injury hospitalization data are available for Army, Navy, Marine Corps, and Air Force active duty military personnel from computerized hospital medical record systems. In 1992, 17,718 injuries accounted for 7.9 percent to 11.6 percent of all hospitalizations in the three services (Table 3-1). Service-specific injury rates were 15.6 hospitalizations per 1,000 person-years (PY) for the Army, 8.3 per 1,000 PY for the Navy (enlisted), and 7.7 per 1,000 PY for the Air Force. In addition, a substantial proportion of the 28,472 hospitalizations for musculoskeletal conditions were due to recurrent or chronic effects of injuries such as lumbar and intervertebral disc disorders and internal knee derangements. Hospitalizations for musculoskeletal conditions

accounted for 12.3 percent to 19.7 percent of all hospitalizations in the three services in 1992 (Table 3-1). (Addendum Tables 3A-1 and 3A-2 on pages 3-16 and 3-17 show the distribution of hospital cases by ICD-9 Principle Diagnostic groups for the Air Force and Army in 1992.)

b. The rates of hospitalization for injuries and for musculoskeletal and connective tissue disorders (ICD-9 710-739) are substantially higher in the Army than in the other two services, possibly due to differences in risk exposure. From 1980/81 to 1992, the injury hospitalization rates decreased 38 percent in the Army (25.1 to 15.6 per 1000PY), 65 percent in the Navy (23.6 to 8.3), and 56 percent in the Air Force (17.7 to 7.7) (Table 3-1). Rates were calculated using mid-year service populations for each year. (Addendum Table 3A-3 shows the frequencies and rates of injury hospitalizations of Army personnel for the top 10 principle diagnosis group (PDG), 3 digit codes, for 1994. These top 10 code groups counted for 41 percent of all injuries in that year, page 3-18.) During the same period, the musculoskeletal hospitalization rates decreased 32 percent in the Navy (14.2 to 9.7) and 20 percent in the Air Force (15 to 12) but increased 75 percent in the Army (16.2 to 28.1). The increasing rate in the Army may be real or may relate to changes in nosologic coding practices. (Addendum Table 3A-4 displays the frequency and rates of hospitalization for the Top 10 musculoskeletal, PDG, 3 digit code groups among Army personnel in 1994. These top 10 accounted for 88 percent of all musculoskeletal and connective tissue disorders in that year.) More work is needed to more fully understand these trends.

Table 3-1. Hospitalizations for Injuries Among U.S. Active Duty Military Personnel

Year:	<u>Army</u> (All active duty)		<u>Navy</u> (Enlisted only)		<u>Air Force</u> (All active duty)	
	1981	1992	1980	1992	1980/81	1992
<i>Total Hospitalizations</i>						
Number	110404	91788	53707	34982	86100*	46059
Case Rate/1000 PY	142.1	142.8	117.1	71.6*	155*	97.3
<i>Injury</i>						
Number	19503	10011	10830	4053	10005	3654
% of all Hospitalizations	17.7	10.9	20.2*	11.6	11.6	7.9
<i>Musculoskeletal</i>						
Number	12553	18050	6512	4738	8400*	5684
% of all Hospitalizations	11.4	19.7	12.1	13.5	9.8*	12.3

*Data are based on best estimates currently available (Jones, 1995).

Section 3-3. Causes of Injury Hospitalization

a. The leading causes of hospitalization for injuries among Army and Air Force active duty military personnel in 1992 are listed in Table 3-2. Athletic and motor vehicle-related injuries are prominent in both services. In both the Army and Air Force, athletic injuries were more common than motor vehicle-related injuries in 1992; the reverse was true in both services in 1980 to 1981 [Jones, 1995 p 30, 31, 39]. The decrease in motor vehicle injuries in the military over the past decade mirrors a national trend that is due in part to safer vehicles and increased seat belt use. Late effects of injury in the Army and complications of medical or surgical procedures in both services are also among the four leading causes of hospitalized injury in 1992. Neither of these latter categories were among the four leading causes of injury in 1980 to 1981. (Addendum Table 3A-5, page 3-20, shows that all of the conditions cause coded as "late effects" of injury in 1994 for the Army were musculoskeletal and connective tissue conditions with ICD-9 diagnosis codes between 710 and 739.)

b. Based on 1992 data, hospitalizations for injuries were more common among males than females (16.1 vs. 11.9 hospitalizations per 1000 PY in the Army; 8.5 vs. 6.5 in the Navy), while hospitalizations for musculoskeletal conditions were less common among males than females (27.2 vs. 34.4 in the Army; 9.4 vs. 12.0 in the Navy) [Jones, 1995, p 16, 28]. Similar patterns by gender were observed for both Army and Navy (enlisted personnel) hospitalizations in 1980. Overall for both acute injuries and musculoskeletal injuries combined, rates were higher in females in the Army and in the Navy.

c. Considering specific causes of injury hospitalization among Army personnel in 1992, males were more frequently hospitalized than females for athletic injuries (3.5 vs. 1.2 per 1000 PY) and for fighting (1.0 vs. 0.3). Females were more frequently hospitalized for complications of medical or surgical procedures (7.3 vs. 2.5 per 1000 PY) and for poisoning by ingestion (2.5 vs. 0.7) [Jones, 1995 p 30]. Similar patterns by gender were observed for Army personnel hospitalizations in 1980.

Table 3-2. Leading Causes of Hospitalization for Injuries Among U.S. Army and Air Force Active Duty Military Personnel, 1992

<u>Cause of injury</u>	<u>Army</u>		<u>Air Force</u>	
	No. of injuries	Case rate per 1000 person-years	No. of injuries	Case rate per 1000 person-years
Late effects of injury	2762	4.3	276	0.6
Athletics/sports	2045	3.2	1047	2.2
Complications med/surg procedure	1993	3.1	978	2.1
Motor vehicle	1629	2.5	714	1.5
Falls or jumps	1224	1.9	405	0.9
Unknown, unspecified	849	1.3	332	0.7
Machinery, tools, other agents	735	1.1	50	0.1
Cutting or piercing objects	659	1.0	163	0.3
Poisoning by ingestion	586	0.9	167	0.4
Fighting	583	0.9	107	0.2
All other	2300	3.6	785	1.7
Total	15365	23.9	5024	10.6

Note: The numbers and case rates for total injuries are different in Tables 3-1 and 3-2. Table 3-1 separates injuries from musculoskeletal conditions (a portion of which are injury-related). Table 3-2 includes under injuries those musculoskeletal and other conditions which received external cause codes for injury.

d. Based on 1992 data for the Navy enlisted personnel, hospitalization rates for injuries were 8.5 per 1,000 PY for Caucasians, 8.7 per 1,000 PY for African-Americans, and 4.7 per 1,000 PY for other races. Corresponding hospitalization rates by race for musculoskeletal conditions were 9.9, 10.2, and 5.3 per 1,000 PY, respectively [Jones, 1995, p. 16]. Similar patterns by race were observed for Navy enlisted personnel hospitalizations in 1980, except the hospitalization rates for injuries were higher for Caucasians (25.3 per 1,000 PY) than for African-Americans (18.6 per 1,000 PY) [Jones, 1995, p. 13].

e. An alternative method used to examine the impact of hospitalizations for injuries focuses on noneffective rates. These rates reflect the nonavailability for service of an individual while in the hospital or on convalescent leave, and incorporate length of hospital stay and subsequent time off duty as a measure of injury severity. A noneffective rate is calculated as the number of persons on the hospital rolls per 1,000 personnel per day. For example, in the Army in 1992, the noneffective rates for motor vehicle-related injury hospitalizations was higher than for athletic injuries (0.19 vs. 0.13 per 1,000 per day), but the case rate for motor vehicle injuries was lower than for athletic injuries (2.5 vs. 3.2 per 1,000 PY) [Jones, 1995, p. 30].

Section 3-4. Strengths and Limitations of Current Hospital Databases

a. Each of the three services has its own hospital discharge database with records of all hospitalizations for service members. Data include patient demographics, duty status, outcome, detailed cause and nature of injury codes (ICD9-CM, up to eight diagnosis fields and eight procedures), residual disability (about 300 codes) and a service-specific code for military occupation (about 1200 codes).

b. All three services maintain separate computerized hospital medical record databases that are coded using standard ICD-9 codes. All acute accidents and injuries in the ICD-9 code range, 800-999, are coded using standard NATO injury codes that also include codes on combat-related injuries. One hundred percent of diagnoses in the 800-999 series are cause coded for the Army. More work is needed to examine other military databases as to the extent of external cause coding. Since 1989, the key database elements have been standardized among all three services. Hospital data can be used to calculate simple admission rates using denominator data or to calculate noneffective rates that reflect time unavailable for duty.

c. At present, both Army and Air Force hospital discharge databases are organized on the basis of each individual admission and service person. The Navy has made more use of the hospital data, which can be found in reports by the Naval Health Research Center and Naval Medical Information Management Center. A major strength of military hospital discharge data is the inclusion of a unique personal identifier (Social Security Number) that make it possible to link information between databases, to link the individual records across multiple admissions for the same injury episode, and to distinguish the first admission for an injury from subsequent readmissions for the same problem or transfers between hospitals. Specific variables have been added to track readmissions since 1989. Medical records of dependents can be also linked to the common Social Security Number of the service person.

d. The existence of a unique identifier overcomes many of the problems encountered in our analyses of civilian databases, such as inability to measure true injury incidence because up to 20 percent of injury admissions to hospitals may be repeat admissions for the same problem [Smith, Langlois, Buechner, 1991]. The identifier also permits indepth analytical approaches to risk factors such as alcohol-related diagnoses. Information on injury admissions could potentially be linked to the Safety Management Information System or to outpatient databases.

e. An important strength of military databases is that excellent denominator data are available from which accurate injury rates can be calculated. The Defense Manpower Data Center (DMDC) can provide extensive demographic data on all service members including age, race, gender, pay grade, date of enlistment, occupation, and hazardous duty pay. The DMDC database is updated semiannually and data by individual year are available. Many recruits enlist for only 2 to 4 years, so that accurate data on person-months will need to be calculated for each person and translated into person-years of exposure.

f. Military hospital record databases have not been routinely linked to denominator databases from which rates can be calculated. The Navy has had considerable experience analyzing hospital discharge data for a variety of health conditions [Helmkamp & Bone, 1987], and the Naval Health Research Center in San Diego, California, has created a database that allows linkage of denominator data and of repeated admissions for individual persons. Their model should be helpful for the use of hospital data by the other services for routine medical surveillance.

g. The Retrospective Case Mix Analysis System (RCMAS) combines several different hospital discharge databases and contains information (including DRGs) on hospitalized members of the Army, Air Force, Navy, and Marines and their dependents. It represents the first effort to establish a DOD-wide hospital discharge database for use in hospital planning and health service utilization review. It includes data on admissions to all military hospitals, as well as civilian hospitals reimbursed under CHAMPUS. This database may be useful for some analyses although retrieval of the entire patient record is difficult with the current version of RCMAS.

h. Another major strength of the military hospital discharge data is that it includes data on the external cause of injury that are not yet available on most civilian databases. Rather than standard E-codes, the military uses NATO E-codes (STANAG codes) which are modified E-codes that more fully describe the frequent military causes of injury. Unlike civilian E-codes, the military cause codes clearly identify sports injuries by specific types of codes, e.g., 200-249. Preliminary analysis of the military hospital discharge data indicates, at least in the Army, that all injury discharges have a

corresponding NATO external cause code. These data are thus much better than any civilian database and will provide important information to develop prevention strategies.

i. An important determinant of injury risk is exposure to hazards that may vary widely by service, by rank, and by job tasks. The ability to use occupational title and pay grade to adjust for occupational exposures is a means of assessing exposure and is enhanced by the recent development of a new DOD coding system for occupational titles. This coding system will allow comparison of injury rates for similar occupational groups in the different services. This is important in comparing injury rates between different groups such as males and females [Dannenberg, 1994]. For example, Zwerling [1993] demonstrated that when adjusted for work-related exposures using occupational titles, female postal workers have higher occupational injury rates than males. Similarly, such analyses of military hospital databases may lead to important insights into specific injury hazards in certain groups.

j. While existing databases can provide useful information for injury prevention purposes, they have some limitations, particularly with regard to exposure issues, details of clinical care, and information on disability. More in-depth follow-up studies involving original data collection will be needed to look at specific problem areas that will be identified by future analyses. One such example is the lack of information on many of the long-term consequences of nonfatal injuries. By linking hospital data to existing disability databases, it may be possible to answer some of these questions.

k. A small proportion of hospitalizations of military personnel occur in civilian rather than military hospitals. Our current understanding is that any admission to a civilian hospital is captured by the military hospital discharge database as part of the reimbursement process. However, the quality and completeness of this data for injuries is unknown at this time.

l. Rates of injury hospitalizations for the services, particularly the Army, appear to be higher than those for civilian populations. However, military hospitalization rates may not be directly comparable to civilian rates. All service members have free health care so there is no potential barrier to hospitalization, i.e., incurring personal cost. In addition, some trainees, especially those living in group quarters such as barracks, may be hospitalized for conditions such as stress fractures or other more minor conditions that would not result in hospitalization in the civilian community. This is done because there is no one to care for such individuals who cannot participate in training during the day.

m. In addition to the above concerns, a number of important questions related to injury hospitalizations deserve further investigation:

(1) Can standard methods for ascertaining numerators and denominators for hospitalization rates be used for all services even though the databases depend on different data management systems?

(2) Which codes for musculoskeletal conditions should be included and excluded in calculations of hospitalized injury rates, so that a common definition can be used across all services?

(3) What factors account for the declining rates of hospitalized injuries in all three services? Are more injuries being treated in outpatient clinics?

(4) Are there changes in coding practices that account for the increasing rate of hospitalized musculoskeletal conditions in the Army while the same rate is decreasing in the Navy and Air Force?

(5) What accounts for the increasing rates over the past decade of reported complications of medical and surgical procedures and of late effects of injury?

(6) Do rates of hospitalized injuries vary by age after taking into account differences in risk exposure by age?

(7) Are data available for the Navy on causes of injury hospitalizations?

(8) Are injuries occurring on ships reported to the hospital data system?

(9) What is the quality of the data available in the various military hospital medical record systems?

(10) Are noneffective rates being calculated consistently across the services, and are such rates a better reflection of the true cost of injuries than hospitalization case rates?

(11) How well are data for military personnel hospitalized in civilian hospitals incorporated into the military data system?

(12) Are there differences in the threshold for hospitalization among the services or even within a service depending on geographic considerations?

Section 3-5. Use of Hospital Databases for Prevention

a. Hospital discharge data that include detailed injury information can be useful for injury prevention and surveillance purposes. The first step is to identify specific high risk groups or hazards for targeting prevention resources. Hospital discharge data can also be used to evaluate the effectiveness of interventions for reducing injury rates. The following examples illustrate some of the uses to which hospital discharge data could be used to develop and evaluate injury prevention strategies.

b. Comparisons of injury rates among different services may identify significant differences in injury risk and suggest new prevention strategies, since different injury prevention policies or practices may serve as natural experiments. Differences in rates for a particular injury may suggest areas for further research, as in studies comparing injury rates among countries [Rockett and Smith, 1987]. Ecological comparisons of disease rates between countries have been the basis for many important new insights into disease prevention, such as the relationship of diet and cancer. One injury example is the difference in injuries between two training centers that prompted follow-up studies on methods to reduce training injuries [Jones 1983, Jones 1993]. Similar situations may be found when comparing rates of other types of injuries among different services.

c. Caution must be exercised in examining inter-service differences for two reasons. First, it is likely that there are important differences in exposure to various risks among the services. Second, there are variations in policies and reporting practices among the services. For example, a reportable injury to the Army Safety Center is one resulting in one or more days of limited duty, compared with 5 or more days for the Navy Safety Center. There may also be differences in admission practices for hospitalization among the services.

d. Analysis of injury trends can provide important insights into causes and prevention strategies for specific injury problems. One problem in analyzing trends is that external factors can influence injury rates. A change in practice related to admitting persons with minor head injuries, for example, can produce a dramatic change in the apparent rate of minor head injuries, but little change in the rate of serious head injury. One approach would be to examine certain injuries, such as skull fractures, that are always likely to be admitted and determine change in relation to other injuries. Analyses using stratification by injury severity will be important in analyzing trend data.

e. The existence of a unique identifier provides a rare opportunity to conduct more indepth epidemiological studies of a variety of factors that may be related to being

injured. As an example, one could study recurrent injuries to the same individual. It is also possible to examine a cohort of persons with alcohol-related diagnoses in the hospital database and examine their injury rates over time compared with a group of persons having no alcohol-related diagnoses. The comparison group can be selected from the total military population and matched on age, gender, and length of service. Utilization of health services could be compared for the two groups. Similarly, a cohort of women who recently delivered a child could be used to examine the effect of pregnancy on injury risks.

f. Another possible study could use a nested case-control design within the longitudinal dataset with controls selected from the DMDC database. One could examine whether women with a prior hospitalization for assault are at an increased risk of homicide or a repeat hospitalization, and whether the risk increases exponentially with each subsequent hospitalization. This information could be used to develop interventions such as screening programs for women at risk with appropriate follow-up.

Section 3-6. Conclusions

a. Hospital discharge records indicate that injuries and musculoskeletal conditions are the largest cause of admission to hospitals in the military and the largest direct costs of medical care. They also have a major impact on troop readiness (larger than any other ICD-9 principle diagnostic group and the noneffective rate is higher). The combined categories of accidents/other injuries and musculoskeletal/connective tissue disorders accounted for slightly more than 30 percent of all Army hospitalizations in 1992.

b. Hospitalization rates for injury appear to be declining for all services over the past decade. For 1980 to 1992, rates of hospitalization for acute injuries (ICD-9 codes 800-999) decreased from about 28 per 1,000 PY to about 24 for the Army and from 21 per 1,000 PY to less than 14 for the Air Force.

c. Musculoskeletal injuries are increasing in the Army but declining in the other services. Reasons for these changes are not known at present and need further research.

d. Major causes of hospitalization include sports injuries, motor vehicle crashes, falls and jumps.

e. Major types of injuries include back and knee injuries as well as fractures.

f. Military hospital discharge databases are an important source of information on severe injuries and are more comprehensive than civilian databases. Although initially collected for administrative purposes and seldom used for epidemiologic studies, the military hospital databases provide a unique opportunity to overcome many of the problems encountered in the use of civilian hospital discharge databases to study injuries. The presence of good external cause codes and the ability to link repeat admissions and to link with other databases are important strengths of the hospital data. Unlike most civilian hospital databases, the military data can be used for separate analyses of both work-related and recreational injuries as well as off-duty motor vehicle injuries. Studies of military occupational injury problems have important implications for both civilian and military populations.

g. The existence of a unique personal identifier is one of the most important features of the military databases for use in medical surveillance and for subsequent research to address important injury problems in the military.

h. Good demographic data on military troop strength is available and can be combined with denominator data. However, other measures of exposure are more difficult to access and need more investigation.

i. Uniform data do exist among services for some variables but more attention needs to be paid to cross-service comparisons.

j. Future studies of hospital data for injury should focus on military readiness and costs.

k. In summary, the military hospital discharge databases provide tremendous potential for injury surveillance in addition to surveillance for other medical problems. To date, the data have been underutilized by the military. The data will be especially useful when they are linked with population-based denominator data from the DMDC. The establishment of a comprehensive surveillance database of hospitalized injuries should be a priority in any injury program in the military.

Section 3-7. Recommendations

As discussed earlier, the hospital discharge databases have perhaps the greatest potential of any medical databases for comprehensive injury surveillance. The following outlines our recommendations for both the increased use of these databases in their current format and recommendations on how to improve their usefulness for surveillance, research and prevention.

- a. Use hospital records routinely for injury and medical surveillance and research both for activities within the military and for research by outside experts.
- b. Implement consistent definitions and classifications across time, place and service (e.g., criteria for hospitalization, noneffective days, injury type/acute vs. musculoskeletal/late effects).
- c. Improve quality of data collection in deployment and combat situations to make consistent with data collection in fixed facilities-especially for the cause of injury information.
- d. Assess quality and consistency of coding and determine need for further training of coders
- e. Focus research on prevention of sport injuries and falls which are both major causes of reduced troop readiness.
- f. Develop strategies to more effectively link and use medical and safety data. Safety center data are an important source of information on injuries but are not linked in any way to hospital data.
- g. Develop automated outpatient data system compatible with inpatient systems.
- h. Investigate family violence and workplace violence using hospital databases.
- i. Examine work vs. nonwork-related injury (cross-cutting all databases).
- j. Evaluate process and quality of data for active duty military personnel treated in civilian hospitals.
- k. Add a free text field to existing databases for detailed cause information to help design and evaluate prevention. There is increasing realization of the value of having a free text field in surveillance databases for injuries to better describe the causes and circumstances of injury. One of the limitations of current hospital databases is that the STANAG or E-codes provide only limited information on the specific causes of injury. The 90-character free text description on the cause of injury in the New Zealand hospital discharge database has proven valuable for identifying specific causes or hazardous products and has lead to the development of effective prevention strategies. The addition of a similar field to military hospital record databases would greatly increase their usefulness for prevention purposes and would also provide an important means to evaluate coding accuracy.

Only through the implementation of these recommendations can we fully realize the large potential that hospital databases have to improve our understanding of injury problems and reduce the burden of injuries to the military. If previous research in the civilian world is to be used as an example, we can expect major reductions in injuries and significant improvements in troop readiness both in peace time and combat situations.

References

1. Dannenberg, A. L., S. P. Baker, G. Li. Intentional and unintentional injuries in women: an overview. Annals of Epidemiology. 1994; 4:133-139.
2. Helmkamp J. C., C. M. Bone. The effect of time in a new job on hospitalization rates for accidents and injuries in the U.S. Navy, 1977 through 1983. J Occup Med 1987; 29:653-659.
3. Jones B. H. Overuse injuries of the lower extremities associated with marching, jogging, and running: a review. Military Med 1983;148:783-787.
4. Jones B. H., M. W. Bovee, J. M. Harris III, D. N. Cowan. Intrinsic risk factors for exercise-related injuries among male and female army trainees. Amer Orthopedic Soc for Sports Medicine 1993;21:705-710.
5. Jones, B. H. Navy, Army and Air Force rates and trends of hospitalization among active duty personnel for injuries and other medical conditions. Unpublished document distributed at Armed Forces Epidemiological Board Injury Working Group meeting, Ogden, Utah, February 1995, 42 pages.
6. Rice, D. P., E. J. Mackenzie and Associates. Cost of Injury in the United States: A Report to Congress. San Francisco, CA: Institute for Health & Aging, University of California and Injury Prevention Center, Johns Hopkins University, 1989.
7. Rockett, I. R. H., G. S. Smith. Injuries in relation to chronic disease: An international view of premature mortality. Amer J Public Health 1987; 77:1345-1346.
8. Smith, G. S., J. A. Langlois, J. S. Buechner. Methodological issues in using hospital discharge data to determine the incidence of hospitalized injuries. Amer J Epidemiol 1991; 134:1146-1158.
9. Writer, J. V. Nonbattle Injuries among U.S. Soldiers in Southwest Asia. Paper presented at Armed Forces Epidemiology Board Injury Prevention Working Group,

Great Lakes Naval Training Center, IL, 5 July 1995. Division of Preventive Medicine, Walter Reed Army Institute of Research, Washington, DC.

10. Zwerling, C., N. L. Sprince, J. Ryan, M. P. Jones. Occupational injuries: comparing the rates of male and female postal workers. Amer J Epidemiol 1993;138:46-55.

ADDENDUM FOR CHAPTER 3

Hospital Admissions Due to Injury

- ◆ Table 3A-1 presents data on the frequencies and rates of hospitalizations of Active Duty Air Force Personnel by Principle Diagnostic Groups (ICD-9 PDG codes) in order of decreasing frequency for CY 1992.
- ◆ Table 3A-2 presents similar data for Active Duty Army Personnel for CY 1992.
- ◆ Table 3A-3 lists the top 10 Injury and Poisoning Diagnostic Groups (ICD-9 Code Groups 800-900) for Active Duty Army Personnel hospitalized in 1994 in order by frequencies and rates.
- ◆ Table 3A-4 lists the top 10 Musculoskeletal and Connective Tissue Disorders Diagnostic Groups (ICD-9 Code Groups 710-739) for Active Duty Army Personnel Hospitalized in 1994 in order by frequencies and rates.
- ◆ Table 3A-5 lists the 23 Musculoskeletal and Injury ICD-9 Code Groups cause coded as "Late Effects of Injury" for Active Duty Army Personnel hospital admissions - CY 1994.

TABLE 3A-1. Hospitalizations for Active Duty Air Force Personnel CY 1992
by Principle Diagnosis Group in order of Descending Frequency

Principle Diagnosis Group	Frequency	Case Rate ¹
Digestive System	10,243	21.63
Musculoskeletal	5,684	12.01
Pregnancy Related	5,392	11.39
Injury/ Poisoning	3,654	7.42
Mental Disorders	3,429	7.24
Genitourinary System	2,932	6.19
Respiratory System	2,748	5.80
Infections/ Parasitic	1,628	3.43
Symptoms	1,619	3.42
Nervous System/ Sensory	1,305	2.76
Circulatory System	1,285	2.71
Neoplasms	1,147	2.42
Skin	871	1.84
Endocrine	476	1.01
Congenital Anomalies	277	0.59
Blood	129	0.27
TOTAL	46,059	97.28

1. Case rates = number of hospitalizations per 1000 person-years.

TABLE 3A-2. Hospitalizations for Active Duty Army Personnel CY 1992
by Principle Diagnosis Group in order of Descending Frequency

Principle Diagnosis Group	Frequency	Case Rate ¹	NER ²
Diseases of the Musculoskeletal System and Connective Tissue	18050	28.08	1.57
Diseases of the Digestive System	13639	21.21	0.42
Accidents, Poisonings and Violence/Injury and Poisoning	10011	15.57	0.73
Complications of Pregnancy, Childbirth, and the Puerperium	9617	14.96	0.42
Diseases of the Respiratory System	7331	11.40	0.20
Mental Disorders	6636	10.32	0.79
Diseases of the Genitourinary System	5221	8.12	0.17
Infective and Parasitic Diseases	4982	7.75	0.16
Symptoms and Ill defined Conditions	3675	5.72	0.12
Diseases of the Nervous System and Sense Organs	3148	4.90	0.26
Diseases of the Circulatory System	3003	4.67	0.27
Neoplasms	2299	3.58	0.23
Diseases of the Skin and Subcutaneous Tissue	2236	3.48	0.08
Endocrine, Nutritional and Metabolic Disease	892	1.39	0.07
Congenital Anomalies	742	1.15	0.06
Diseases of the Blood and Blood-forming Organs	306	0.48	0.01
TOTAL	91788	142.77	5.56

1. Case rates = number of hospitalizations per 1000 person-years.

2. NER = (Non-effective rate) number per 1000 person-days in a hospital or on convalescent leave.

Table 3A-3. Top 10 Injury and Poisoning Diagnostic Groups
(ICD-9 Code Groups 800-900) for Active Duty Army Personnel
Hospitalized in 1994

Diagnostic Code Group	ICD-9 Three Digit Code	Frequency	Rate*
Fx of ankle	824	452	0.8
Intracranial inj of oth/unspec nature	854	355	0.6
Oth complications of procedures, NEC	998	337	0.6
Fx of face bones	802	330	0.6
Sprains/strains of knee/leg	844	283	0.5
Dislocation of knee	836	280	0.5
Compl peculiar to certain spec procedures	996	227	0.4
Fx of radius/ulna	813	216	0.4
Fx of one or more phalanges of hand	816	213	0.4
Open wound of finger	883	179	0.3
TOTAL	---	2872	5.1

* Rates are calculated per 1000 soldiers per year based on mid-interval 1994 DMDC Data.

TABLE 3A-4. Top 10 Musculoskeletal and Connective Tissue Disorders
Diagnostic Groups (ICD-9 Code Groups 710-739) for Active Duty
Army Personnel Hospitalized in 1994

Diagnostic Code Group	ICD-9 Three Digit Code	Frequency	Rate*
Internal derangement of knee	717	2924	5.3
Oth derangement of joint	718	1412	2.6
Oth/unspec disorder of joint	719	1276	2.3
Oth disorders of synovium, tendon/bursa	727	1258	2.3
Intervertebral disc disorders	722	979	1.8
Oth/unspec disorders of back	724	861	1.6
Acquired deformities of toe	735	859	1.6
Oth disorders of bone/cartilage	733	852	1.6
Peripheral enthesopathies/allied syndromes	726	814	1.5
Osteoarthritis/allied disorders	715	580	1.1
TOTAL	---	11815	21.7

* Rates are calculated per 1000 soldiers per year based on mid-interval 1994 DMDC Data.

TABLE 3A-5. Musculoskeletal and Injury ICD-9 Diagnostic Code Groups listed as Caused by "Late Effects of Injury" for Hospital Admissions of Active Duty Army Personnel - CY 1994

Diagnostic Code Group	ICD-9 Code	Frequency	% Total
Internal derangement of knee	717	554	24
Other disorders of bone/ cartilage	733	403	18
Other derangement of joint	718	344	15
Other/ unspec disorder of joint	719	274	12
Osteoarthritis/allied disorders	715	111	5
Other/ unspec disorders of back	724	110	5
Other/ unspec arthropathies	716	92	4
Peripheral enthesopathies/ allied syndromes	726	79	3
Other disorders of synovium, tendon/bursa	727	69	3
Other disorders of soft tissues	729	61	3
Disorders of muscle, ligament/ fascia	728	47	2
Intervertebral disc disorders	722	41	2
Other acquired deformity	738	29	1
Other acquired deformities of toe	736	28	1
Other disorders of cervical region	723	18	1
Osteochondropathies	732	15	1
Spondylosis/ allied disorders	721	7	0
Osteomyelitis, periostitis/ oth infect invol bone	730	7	0
Acquired deformities of toe	735	5	0
Arthropathy associated with infections	711	3	0
Flat foot	734	2	0
Curvature of spine	737	2	0
Ankylosing spondylitis/ oth inflam spondylopathies	720	2	0
	TOTAL	2303	100

CHAPTER 4

OUTPATIENT CARE FOR TRAINING AND OTHER INJURIES

Section 4-1. Introduction

The following section focuses on musculoskeletal injuries in military populations. This category of injuries is treated primarily on an outpatient basis. Unfortunately, there is no DOD or service-wide outpatient surveillance data available. Therefore, we must rely on existing epidemiological studies to estimate the size of the problem, identify risk factors, and begin to propose and test preventive measures. Most of the research data has been obtained on Marine and Army recruits, Army Infantry soldiers, and Naval Special Warfare candidates. Risk factors have been identified which are amenable to intervention. However, few intervention trials have been undertaken. An outpatient surveillance system has been developed to obtain a research based musculoskeletal injury database in select military populations. This recent system suggests that simple surveillance systems can provide important data.

Section 4-2. Size of the Problem

a. Military physical training (PT) programs are critical to operational readiness. High musculoskeletal injury rates occur as a result of PT, especially during military recruit training (Tables 4-1 and 4-2). These rates are fairly uniform during recruit training. The rates are also high for infantry and special forces training. The majority of these injuries are lower extremity musculoskeletal injuries. The data suggest that female trainees experience a two times greater risk of musculoskeletal injury during training than their male counterparts. Further, the data suggest that women are at a 1.2-10.0 times greater risk of suffering stress injuries of bone than men in U.S. military training populations (Table 4-3). However, it has been demonstrated recently that the increased injury rates among women may be due to lower levels of fitness at the time of entry into training (Jones et al, 1993) and not gender per se. The rates of injuries for military recruits and infantry soldiers appear to be about the same or a little higher than for endurance athletes, but considerably lower than for contact sports participants (Kraus and Conroy, 1984; Watson, 1993).

b. Comparisons of military training injury rates with those of civilian athletes and exercise participants provide a perspective for understanding the magnitude of the problem of injuries in the military. Prospective epidemiological data on all sports injuries collected in a casualty ward for 1 year in a well defined metropolitan area with 124,321 inhabitants (Lindblad et al, 1991) showed the incidence of sports injury was 61 per 1000 active sports players per year and 15 per 1000 inhabitants in the catchment population per year. Reviews of injuries among distance runners report annual overall incidences ranging from 25-65 percent for heterogeneous populations of recreational and competitive runners (Table 4-4). These injuries were severe enough to cause a reduction or cessation of

training and 12-22 percent sought medical attention (Samet et al, 1982; Marti et al, 1988; Koplan et al, 1982; Macera et al, 1989; Marti, 1988; Walter et al, 1989). Annual rates as high as 1.2 - 2.3 injuries per athlete (120-230 injuries per 100 person-years) have been reported, (Table 4-5). A majority of these injuries (76 percent) resulted in time lost from activity (Requa, 1993). Garrick (1986) reported that 49 percent of aerobic dance participants experience injuries over an average follow up period of 12-13 weeks. Twenty percent of these aerobics participants suffered injuries severe enough to require professional medical attention.

Table 4-1. Rate of Outpatient Musculoskeletal Injuries during Military Training

Study	Year	Population	Observation Period	Rate (n/100/month)	
				Female	Male
Tomlinson	1987	Army Infantry n=15, 295; m=14,178; f=1117	8 wks	3.3 ^a	6.6 ^a
Riddell	1990	Royal Marines Commando Training n=18,040; all male	52 wks (1981) (1985)	-	34.4 33.5
Linenger	1993	Naval Special Warfare n=88; all male	25 wks	-	29.7
Knapik	1993	Army Infantry n=298; all male	26 wks	-	11.8 ^a
Reynolds	1994	Army Infantry n=181; all male	52 wks	-	6.5 ^a

Abbreviations: a= all injuries

Table 4-2. Cumulative Incidence of Outpatient Musculoskeletal Injuries during Military Training

Study	Year	Population	Observation Period	Cumulative Incidence (%)	
				Female	Male
Kowal	1980	Army Recruits n=400; all females	8 wks	54	-
Shaffer & Brodine	1993	Marine Recruits n=1296; all male	12 wks	-	36.0 ^a
Jones	1993	Army Recruits n=391; m=124, f=186	8 wks	50.5 ^a 44.6 ^b	27.4 ^a 20.9 ^b
Jones	1993	Army Recruits n=303; all male	12 wks	-	37.0 ^b
Knapik	1993	Army Infantry n=298; all male	26 wks	-	50.7 ^a
Shaffer & Brodine	1994	Marine Recruits n=1132; all male	11 wks	-	27.3 ^a
Brodine & Shaffer	1995	Naval Special Warfare n=451; all male	25 wks	-	48.2 ^a

Abbreviations: a= all injuries; b= lower extremity

c. Results of studies reported in the literature clearly show that the rates of injury associated with vigorous weight bearing exercise are high. These high injury rates can be attributed to repetitive strenuous physical activities for both civilian exercise participants and military trainees. Available data suggest that injury rates among military recruits and infantry soldiers are higher than for distance runners and about the same as or a little lower than competitive athletes and vigorous exercise participants.

Table 4-3. Cumulative Incidence of Stress Fractures Among Military Trainees

Study	Year	Population	Observation Period	Cumulative Incidence Females	Cumulative Incidence Males	Relative Risk F/M
Protzman	1977	Cadets, West Point <i>n</i> =1330; <i>m</i> =1228, <i>f</i> =102	8 wks.	10.0%	1.0%	10.0
Reinker	1979	Army trainees	8 wks.	12.0%	2.0%	6.0
Kowal	1980	Army trainees <i>n</i> =347; all females	8 wks.	21.0%	-	-
Scully	1982	Army trainees <i>n</i> =6677; all males	8 wks.	-	1.3%	-
Brudvig	1983	Army trainees <i>n</i> =295; <i>m</i> =144, <i>f</i> =151	8 wks.	3.4%	0.9%	3.8
Gardner	1988	Marine recruits <i>n</i> =3025; all males	12 wks.	-	1.3%	-
Pester & Smith	1992	Army recruits <i>n</i> =109,296; <i>m</i> =76,237; <i>f</i> =33,059	8 wks	1.1%	0.9%	1.2
Jones	1993	Army recruits <i>n</i> =310; <i>m</i> =124, <i>f</i> =186	8 wks	12.3%	2.4%	5.1
Shaffer & Brodine	1994	Marine Recruits <i>n</i> =1138; all male	11 wks	-	3.8%	-
Brodine & Shaffer	1995	Naval Special Warfare <i>n</i> =451; all male	25 wks	-	9.8%	-
Brodine & Shaffer	1995	Marine Officer Candidate School. <i>n</i> =110; all female		11.5%	-	-

Table 4-4. Annual Injury Incidence Among Runners in Civilian Studies

Reference	Sex	N	Duration of study (years)	Annual Incidence Rate (%per/yr)
Koplan et al (1982)	m+f	1168	1	37%
Jacobs & Berson (1986)	m+f	451	2	24%
Lysholm & Wiklander (1987)	m+f	All 60 LDR 28	1	65% 57%
Marti et al (1988)	m	4358	1	46%
Marti (1988)	f	428	1	40%
Holmich et al (1988)	m	60	1	43%
Holmich et al (1989)	m+f	1426	1	31%
Macera et al (1989)	m	485	1	52%
	f	98	1	49%
Walter et al (1989)	m+f	1265	1	50%
	m	980	1	49%
	f	301	1	46%
Bovens et al (1989)	m+f	73	1.6	52%

Abbreviations: m = male; f = female; LDR = long distance runners

Table 4-5. Annual Injury Rates in Competitive and Recreational Athletes

Reference	Population	Observation Period (wks)	Annual Injury Rate (n/100 persons/yr)
Watson, 1993	Competitive athletes n=314; m=243; f=81	52	117 (acute) 93 (overuse)
Korkia et al, 1994	Triathletes n=155	8	197
Requa et al, 1993	Recreational adult fitness n=986; m=418; f=568	12	233

Section 4-3. Types of Injuries.

a. The most common types of injuries seen in military and athletic populations are musculoskeletal overuse injuries. The majority of the injuries occur at or below the knee (Table 4-6). A study during Army infantry basic training reported that the five most commonly diagnosed conditions were pain attributed to overuse or stress syndrome (23.8 percent), muscle strains (8.6 percent), ankle sprains (6.3 percent), overuse knee injuries (5.9 percent), and stress fractures (3.0 percent) (Jones et al, 1993B). Among 298 infantry soldiers, the most common injury diagnosis was musculoskeletal pain, followed by strains, sprains, and cold-related injuries (Knapik et al, 1993). The distribution (percent) of

commonly diagnosed injuries in Army male recruits was low back pain (7.3 percent), tendonitis (6.5 percent), sprains (4.8 percent), muscle strains (3.2 percent), and stress fractures (2.4 percent) (Jones et al, 1993A). In the same training program, the incidence was higher for women, and the distribution of the most frequent injuries was muscle strains (15.6 percent), stress fractures (12.3 percent), sprains (5.9 percent), tendonitis (5.5 percent), and overuse knee complaints (2.1 percent). Lower extremity injuries were also found to be common among 1,136 male Marine recruits at the Marine Recruit Depot (MCRD), in San Diego (Brodine and Shaffer, 1995). The most common specific injuries seen were iliotibial band syndrome (6.6 percent), blisters (6.1 percent), stress fractures (3.9 percent), ankle sprains (3.7 percent), patellar tendonitis (1.1 percent), shin splints (0.9 percent), and patellofemoral syndrome (0.4 percent). Higher injury rates have been reported in Naval Special Warfare training (Brodine and Shaffer, 1995). Among 453 trainees, the incidence of the most common injuries was iliotibial band syndrome (10.9 percent), stress fractures (9.8 percent), patellofemoral syndrome (8.2 percent), contusions (7.5 percent), ankle sprains (5.5 percent), low back injuries (4.6 percent), periostitis (3.1 percent), and Achilles tendonitis (1.8 percent).

b. Injuries are important in terms of loss of time from work and training and decreased military readiness. The loss of time varies with the type of injury (Table 4-7). In a study by Reynolds et al, fractures accounted for the highest number of lost duty days (103.2 days/injury) followed by sprains (16.7 days/injury). Other traumatic injuries, tendinitis, strains and musculoskeletal pain caused lesser amounts of limited duty per injury.

Table 4-6. Injury Distribution by Body Part in Military Training

Study	Population	Observation Period (wks)	Site (% of injuries)				
			Foot	Ankle	Lower Leg	Knee	Lower Back
Riddell, 1990	Royal Marines Commando Training Center n=18,040; all male	52(1981)	14.7	16.7	3.8	26.7	-
		52 (1985)	11.9	14.2	5.5	18.8	
Linenger et al, 1993	Naval Special Warfare, n=88	25	9.8	14.0	11.2	34.3	6.3
Jones et al, 1993	Army infantry n=303; all male	12	10.9	10.9	8.6	10.2	5.9
Knapik et al, 1993	Army infantry n=298; all male	26	6.6	12.3	2.4	10.4	6.6
Shaffer & Brodine, 1993	Marine recruits n=1296; all male	12	34.9	12.9	3.1	21.7	4.1
Brodine & Shaffer, 1995	Naval Special Warfare trainees n=450; all male	25	9.8	14.0	11.2	34.3	6.3

Table 4-7. Average Limited Duty Days by Type of Musculoskeletal Injury Among Infantry Soldiers*

Injury	Limited Duty (Days/injury)
Fractures	103.2
Sprains	16.7
Other Traumatic Injuries	7.6
Tendonitis	7.0
Strains	3.0
Musculoskeletal pain	2.8

* Reynolds, K., et al, 1994

c. The implications of these injuries in terms of patient morbidity, attrition rates and training costs for military personnel are staggering. It has been estimated that injuries among 22,000 male recruits during 12 weeks basic training at MCRD, San Diego result in more than 53,000 lost training days and cost more than \$16.5M per year (Shaffer et al, 1994). The morbidity associated with injuries in the military is much greater than that associated with illness. "Sick call" clinic visit rates have been shown to be about the same for injuries and illnesses among male and female Army trainees (Table 4-8). However, rates of visits only provide a partial picture of morbidity. Examining the amount of morbidity in terms of days of medical restriction reveals a vastly different picture. The rates of days of limited duty for Army trainees have been shown to be 5-20 times higher for musculoskeletal injuries than for disease/illness (Table 4-8). Similarly, the days of limited duty for Army infantry soldiers have been demonstrated to be 11 times higher for musculoskeletal injury as compared to illness (Table 4-9).

Table 4-8. Rates (n/100 recruits/mo) of Injury and Illness among Male (m) and Female (f) Army Recruits (Ft. Jackson, 1984, 8 weeks, n=310; m=124, f=186)

	Gender	Injury Rate	Illness Rate	RR**
Sick Call Visits (Rate=n/100/mo)	male	22.0	26.4	0.8
	female	39.6	37.2	1.1
Days of Limited Duty (Rate=days/100/mo)	male	40.0	8.0	5.1
	female	129.0	6.0	21.5

Abbreviations: ** RR = Rate Ratio = Inj Rate/Ill Rate

Jones et al, 1988

Table 4-9. Rates of Injury and Illness among Male Army Infantry Soldiers
(Ft. Drum, 1989, 10 weeks, n=351)

	Injury Rate (n/100/mo)	Illness Rate (n/100/mo)	RR**
Sick Call Visits	19.6	12.0	1.6
Days of Limited Duty	113	11	11.0

Abbreviations: ** RR = Rate Ratio = Inj Rate/Ill Rate

Section 4-4. Causes and Risk Factors for Injury

a. A key to the etiology, prevention and treatment of overuse injuries lies in an understanding of the factors associated with these injuries. A number of risk factors have been identified (Table 4-10). The risk factors include past physical activity, low levels of previous occupational and physical activity, previous injury history, high running mileage, high amount of weekly exercise, smoking, and age. The data is contradictory with respect to age. Studies by Tomlinson et al (1987) and Knapik et al (1993) identify younger age as a risk factor for injury among infantry soldiers, whereas the study by Jones et al (1993B) states that older age is a risk factor among Army trainees. Overall, many of these risk factors are amenable to intervention.

Table 4-10. Risk Factors for Injury

Factor	Supporting literature
Low levels of past physical activity	Kowal, 1980; Jones et al., 1993A; Jones et al., 1993B; Brodine and Shaffer, 1995A; Brodine and Shaffer, 1995B
Low level of physical fitness	Kowal, 1980; Jones et al., 1993A; Jones et al., 1993B; Knapik et al., 1993; Reynolds et al., 1994; Brodine and Shaffer, 1995A; Brodine and Shaffer, 1995B
Previous injury history	Jones et al., 1993B; Brodine and Shaffer, 1995A
High running mileage	Jones et al., 1993B
High amount of weekly exercise	Tomlinson et al., 1987
Smoking	Reynolds et al., 1994; Jones et al, 1993B
Age	Tomlinson et al., 1987; Knapik et al., 1993; Jones et al., 1993B

b. Recent studies have stressed the importance of entrance physical fitness and subsequent injury. Much of military training centers around weight bearing physical training, such as marching or running. A number of studies in both civilian and military populations have demonstrated a dose-response curve in relation to running and weight bearing activities and injuries (Cowan and Jones, 1991; Pollack et al, 1977). Further, as the frequency, duration, or total amount of training increases, the injuries also increase, until a point is reached at which injuries increase disproportionately with changes in physical fitness.

c. Most of the studies which have been aimed at identifying injury risk factors have been based on retrospective chart reviews or prospective questionnaires. There are very few studies which have obtained prospective data on biomechanical factors related to the risk of sustaining an overuse injury of the lower limb (Jones et al, 1993B; Cowan et al, 1994; Beck et al, 1995; Cullison et al, 1995; Kaufman et al, 1995). The biomechanical factors can be divided into static (anatomical) and dynamic (gait) categories. Identified anatomical parameters include back and hamstring flexibility (Jones et al, 1993B), high arches (Cowan et al, 1994), bone geometry (Beck et al, 1995), and knee hyperextension (Cullison et al, 1995). The dynamic parameters include weight transfer, propulsive forces, pronation, foot arch characteristics, shock absorption, and side-to-side asymmetry (Kaufman et al, 1995). Several of these biomechanical factors can be modulated through equipment or footwear changes.

Section 4-5. Prevention Strategies

a. Preventive strategies should be directed at the primary factors contributing to risks for musculoskeletal injuries, such as level of intensity of the training, physical fitness, and equipment (e.g., footwear).

b. The specific approach to achieving higher levels of physical fitness while minimizing injury rates is dependent on the particular populations being considered. For example, with military recruits there is limited access prior to arrival to boot camp. Therefore, the most effective way to improve the level of physical fitness may be to alter the training regimen, by "ramping up" the intensity of the training events gradually. This approach accommodates the incoming, poorly fit recruits without compromising the fitness of the graduating recruits. A training intervention was implemented by the San Diego, MCRD to reduce injuries and maintain fitness of Marine recruits. The intervention included reduction in the amount of running miles, gradual build up of exercise and military hiking, and emphasis of aerobic activities in early training phases before progressing to anaerobic strength and conditioning. Evaluation of this intervention demonstrated a significant reduction in all overuse type injuries. Specific high impact injuries such as lower extremity stress fractures

were reduced by 55 percent, which resulted in 370 fewer stress fractures per year with a cost savings of over \$4.5 million at the San Diego Recruit Depot. Outgoing recruit fitness, as measured by the 3 mile timed run at the end of training, remains equally high compared to before the intervention (20:53 vs 20:20).

c. After basic training, individuals are required to maintain at least a modest level of physical fitness regardless of job requirements. Further, physical fitness is equated with aerobic fitness. However, a high level of aerobic fitness may not be required by soldiers to perform their individual job function. Future efforts need to more closely link specific job assignments with requirements for muscular strength and endurance.

d. A significant etiologic factor for running injuries is the amount of training. A number of studies in both civilian and military populations have demonstrated a dose-response relationship between running or other weight bearing activities and injuries. Tomlinson et al (1987) found that soldiers who exercised ten or more hours per week were at increased injury risk. Kowal (1980) stated that training over 3 days per week resulted in a significant increase in the injury rate for previously sedentary women. Similarly, Marti (1988) observed that women who ran more than 20 km/week were at increased risk for injury. Pollock et al (1977) showed that as the frequency, duration, or total amount of training increased, the injuries also increased until a point was reached at which injuries continued to increase substantially (200 to 300 percent) while physical fitness increased minimally (less than 10 percent). Thus, it can be concluded that there is an optimum amount of physical training which will result in increased physical conditioning without corresponding disproportionate increases in injury rates.

e. Another etiologic factor for training injuries may be footwear. The cushioning characteristics of footwear worn by trainees has been tested using a mechanical impact tester to compare military boots to running shoes (Figure 4-1). An inexpensive orthotic can be inserted into the military combat boot to reduce excessive shock loading by 33 percent, without any alterations to the boot design. However, the choice of an orthotic material is crucial. In separate prospective studies during vigorous military training, the addition of a neoprene shock absorbing insole has been shown to reduce the incidence of overuse injuries (Schwellnus et al, 1990), whereas use of a sorbathane insert was not beneficial (Gardner et al, 1988). Neoprene compacts quickly and has a short useful life, so other advanced orthotic materials which offer good shock absorption characteristics and greater durability may be better suited to military needs. These newer materials await prospective testing. In addition, military boots lack adequate shock absorption characteristics when compared to a running shoe (Figure 4-1). A redesign of military boots could probably achieve a better design which would reduce lower extremity injuries, and meet other mission requirements.

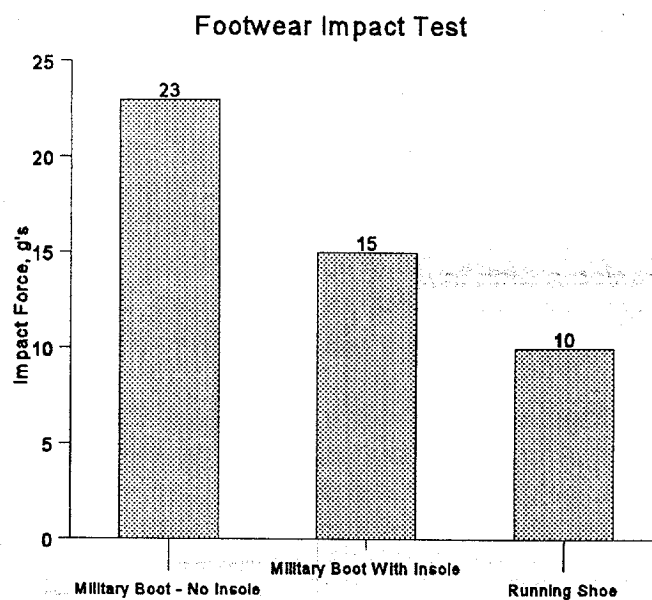


Figure 4-1. Boot impact test using an impact tester to determine cushioning characteristics. The results illustrate the ability to reduce impact loading in a military combat boot by 33 percent through the use of a shock absorbing insole. A comparison is also made to a running shoe. (Test performed by Hagy Biomechanics)

f. Equipment may also play a role in the prevention of other types of training injuries. A well-designed epidemiologic study has been performed to address ankle injuries among paratroopers. Airborne soldiers have long been among those at highest risk of serious injury. Reported annual injury rates generally range from 1 percent to 15 percent (Lillywhite, 1991; Amoroso et al, 1991). Ankle injuries account for 30 percent to 60 percent of all military parachute injuries (Davidson, 1990). During Operation Just Cause in Panama (Miser et al, 1991), 8 percent of Army Rangers (51/640) sustained ankle injuries, 39 percent of these soldiers had to be evacuated, and 27 percent were nonambulatory. In order to reduce the incidence of jump-related ankle sprains, a prospective, randomized trial of an outside-the-boot ankle brace was conducted (Ryan et al, 1994). A group of 745 volunteers from the U.S. Army Airborne School at Fort Benning, Georgia, participated. Of this group, 369 were assigned to wear braces and 376 served as controls. Each volunteer made five static-line parachute jumps. The incidence of ankle sprains was 1.9 percent in nonbrace wearers and 0.3 percent in brace wearers (Figure 4-2). This difference was statistically significant ($p=0.03$). Other injuries were not affected by the brace. The parachute ankle brace is a simple device that can be used to reduce injury rates among paratroopers. These data demonstrate the value of developing a program to identify and modify risk factors associated with military operations.

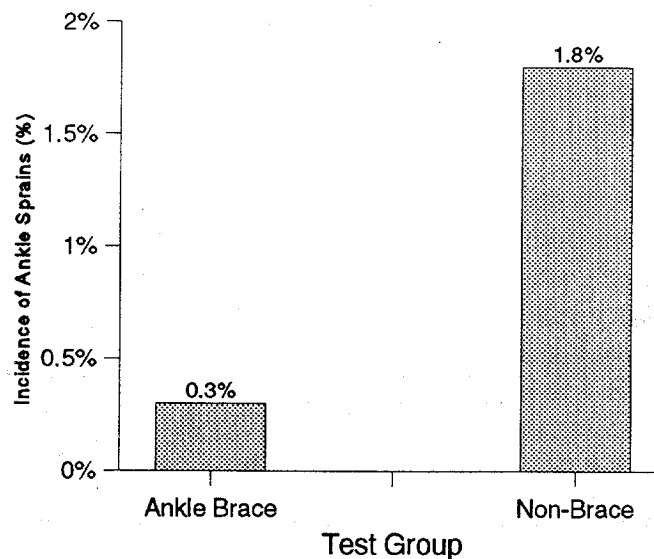


Figure 4-2. Incidence of Ankle Sprains in Brace vs. Non-brace Groups at Airborne School, Fort Benning, 1992. 745 Jumpers, 3885 Jumps. Risk Ratio (NB vs. B) = 7.1, $p = 0.03$ (Ryan, 1994)

g. Research such as that described in boot insoles suggest that simply having a good hypothesized strategy to prevent injuries (i.e., more shock absorbent boots) is not sufficient. Prevention strategies should be tested prior to fielding and once in place even successful ones such as the ankle brace should be monitored for ongoing success.

Section 4-6. Outpatient Surveillance System

a. Unlike inpatient clinical events which are maintained on databases for all three services, there is no comprehensive outpatient morbidity surveillance system. This presents great limitations in the ability to determine outpatient disease rates, identify risk factors, perform cost-benefit analyses, and design preventive interventions. An automated data collection system that contains information regarding the personal demographics, medical presentation, diagnoses and disposition, and other potentially relevant data could greatly facilitate these processes. It could further serve as a real-time surveillance tool to identify changes in patterns of injury or disease distribution.

b. The Naval Health Research Center has developed a PC-based software application for the purpose of supporting epidemiological research in musculoskeletal injuries. The system has features of both clinical and research databases. Demographics, clinic visit

information, and ICD-9 diagnoses are entered on data entry sheets, which also serve as the hard-copy medical record. The system was also programmed to perform administrative functions and generate required reports. Currently, the system is in use at several Navy, Marine Corps, and Air Force training sites.

c. Preliminary data from six training sites with operational outpatient morbidity surveillance systems have demonstrated the utility of the software. Databases have been developed from these sites which have varying volumes of outpatient encounters and show that musculoskeletal injury incidence is associated with the intensity of training. The highest incidence of injury in males occurs during Naval Special Warfare Training (42 percent), followed by U.S. Marine Corps basic training (26 percent), and U.S. Navy basic training (11 percent). Among women, U.S. Marine Corps officer candidate training results in an injury incidence of 61 percent, U.S. Marine Corps basic training (45 percent) and U.S. Navy basic training (11 percent). At each site, these databases are also being used to provide clinical outcome information on enrolled subjects in a variety of research study designs.

Section 4-7. Summary and Recommendations

a. Research suggests that musculoskeletal injuries are a significant problem in the military. Although the majority of studies have been conducted in military recruit training populations, studies conducted in operational forces provide documentation that there is a large problem in these populations as well. Data collected show that there is a wide variation in injury rates which is largely dependent on the levels of physical fitness of service member and the amount of the physical training. Given the magnitude of the problem, surveillance can identify high risk populations for the purpose of prioritizing research and prevention studies. No uniform outpatient surveillance system exists throughout the Department of Defense to capture data. One outpatient automated data collection system has been developed and implemented at Navy, Marine and Air Force training sites for the purpose of injury surveillance. This is a good model system which has proven useful in obtaining injury related data.

b. Studies to date indicate that several injury risk factors (e.g., training, physical fitness, smoking and footwear) are modifiable and thus suggest that prevention strategies can be successfully designed. The following recommendations are made:

(1) **Establish** routine comprehensive **outpatient injury surveillance**. The surveillance tool should ideally have dual clinical/administrative functions. While DOD-wide fully automated outpatient records and surveillance systems are being developed, an outpatient injury sentinel site system modeled after the National Electronic Injury Surveillance System could serve as an interim tool for monitoring injury occurrences.

(2) **Perform focused research** in selected populations to delineate intrinsic and extrinsic risk factors for injury. The research should be focused on incidence, severity, costs, and causes. Results from these studies can be used to develop screening procedures to identify individuals at risk and suggest methods which might be used to reduce injuries in training and operational forces.

(3) **Design and evaluate preventive strategies.** The preventive strategy should be based on solid scientific evidence of potential efficacy, beginning with existing studies, that identify risk factors, which are amenable to modification. Intervention trials should examine current practice and policy with specific emphasis on intensity/frequency/duration of training, type of activity, specificity of training, and appropriateness of current fitness standards. Efforts should be made to continue exploring the association between fitness and smoking. The design and usage of equipment and footwear should also be examined.

(4) **Implement programs and monitor effectiveness** of interventions to assure their effective application in operational circumstances.

(5) **Broaden research efforts** to establish rates for other categories of outpatient-treated injuries beyond training injuries and extend to populations other than Army and Marine recruits and infantry soldiers. The recommended elements of a program to systematically prevent injuries treated in outpatient clinics include:

- (a) Surveillance to identify problems.
- (b) Research to determine causes and mechanisms.
- (c) Intervention trials to determine prevention strategy efficacy.
- (d) Program implementation.
- (e) Program monitoring to track success and identify new hazards.

References

1. Amoroso, P. J., B. H. Jones et al. A Comparison of Musculoskeletal Injury Rates Among Men and Women during Airborne Training. *USARIEM*, 1991.
2. Beck, T.J., C. B. Ruff, R. D. Shaffer, K. Maxwell-Williams, G. L. Kao, S. Brodine. Prediction of stress fractures in military recruits with DXA derived structural geometry. *Trans Orthop Res Soc* 20(1):200, 1995.
3. Bense, C. K., R. N. Kish. Lower extremity disorders among men and women in Army basic training and effects of two types of boots. NATICK/TR-83/026, U.S. Army Research and Development Laboratories, Natick, MA, 1983.
4. Blair, S.N., H. W. Kohl, N. N. Goodyear. Rates and risks for running and exercise injuries: studies in three populations. *Research Quarterly for Exercise and Sport* 58:221-228, 1987.
5. Bovens, A. M., G. M. Janssen, H. G. Vermeer, J. H. Hoeberigs, M. P. Janssen et al. Occurrence of running injuries in adults following a supervised training program. *Int J Sports Med* 10(Suppl. 3):S186-S190, 1989.
6. Brodine, S. K., R. A. Shaffer, 1995. Unpublished data.
7. Brudvig, T. J. T. D. Grudger, L. Obermeyer. Stress factors in 295 trainees: a one year study of incidence related to age, sex, and race. *Milit Med* 148 666-667, 1983.
8. Cowan, D. N., B. H. Jones. Running exposure, training injuries, and physical fitness (abstract 236). *Med Sci Sport Exerc*, 1991: 23 Suppl: 40.
9. Cullison, 1995. Unpublished data.
10. Davison, D. J. A review of parachuting injuries. *Inj* 21:314-316, 1990.
11. Gardner, L. I., J. E. Dziados, B. H. Jones, J. F. Brundage, J. M. Sullivan, P. Gill. Prevention of lower extremity stress fractures: a controlled trial of a shock absorbent insole. *Am J Pub Health* 78:1563-1567, 1988.
12. Garrick, J. G., D. M. Gillien, P. Whiteside. The epidemiology of aerobic dance injuries. *Am J Sports Med* 14:67-72, 1986.

13. Garrick, J. G., R. K. Requa. Injuries in high school sports. *Ped* 61:465-469, 1978.
14. Hoerberigs, J. H. Factors related to the incidence of running injuries: A review. *Sports Med* 13:408-422, 1992.
15. Holmich, P., E. Darre, F. Jahnsen, T. Hartvig-Jensen. The elite marathon runner: problems during and after competition. *Br J Sports Med* 22:19-21, 1988.
16. Holmich, P., S. W. Christensen, E. Darre, F. Jahnsen, T. Hartvig. Non-elite marathon runners: health, training, and injuries. *Br J Sports Med* 23:177-178, 1989.
17. Jacobs, S. J., B. L. Berson. Injuries to runners: a study of entrants to a 10,000 meter race. *Am J Sports Med* 14:151-155, 1986.
18. Jones, B. H. Overuse injuries of the lower extremities associated with marching, jogging, and running: a review. *Milit Med* 148:783-787, 1983.
19. Jones, B. H., M. W. Bovee, J. J. Knapik. Associations among body composition, physical fitness, and injury in men and women Army trainees. Chapter 9 in Body Composition and Physical Performance. Marriott BM and Grumstrup-Scott J, (eds). National Academy Press, Washington DC, pp 141-173, 1992.
20. Jones, B. H., M. W. Bovee, J. M. Harris, D. N. Cowan. Intrinsic risk factors for exercise related injuries among male and female Army trainees. *Am J Sports Med* 21(5):705-710, 1993A.
21. Jones, B. H., D. N. Cowan, J. P. Tomlinson, J. R. Robinson, D. W. Polly, P. N. Frykman. Epidemiology of injuries associated with physical training among young men in the Army. *Med Sci Sports Exer* 25(2):197-203, 1993B.
22. Jones, B. H., J. M. Harris, T. N. Vinh, C. Rubin. Exercise induced stress fractures in stress reactions of bone: Epidemiology, etiology and classification. *Exer Sports Sci Rev* 17:379-422, 1989.
23. Jones, B. H., R. Manikowski, J. H. Harris, J. Dziados, S. Norton, T. Ewart, J. A. Vogel. Incidence of and risk factors for injury and illness among male and female Army basic trainees. Technical Report T19-88, U.S. Army Research Institute of Environmental Medicine, Natick, Mass, June, 1988.
24. Kaufman, K. R., 1995. Unpublished data.

25. Kimsey, C. D. The epidemiology of lower extremity injuries in United States Marine Corps recruits. Unpublished doctoral dissertation, 1993.
26. Knapik, J., P. Ang, K. Reynolds, B. Jones. Physical fitness, age, and injury incidence in infantry soldiers. *J Occup Med* 35(6):598-603, 1993.
27. Koplan, J. P., K. E. Powell, R. K. Sikes et al. An epidemiologic study of the benefits and risks of running. *JAMA* 248:3118-3121, 1982.
28. Kowal, D. M.. Nature and causes of injuries in women resulting from an endurance training program. *Am J Sports Med* 8:265-269, 1980.
29. Kraus, J. F., C. Conroy. Mortality and morbidity from injuries in sports and recreation. *Ann Rev Pub Health* 5:163-192, 1984.
30. Lillywhite, L. P. Analysis of Extrinsic Factor Associated with 379 Injuries Occurring During 34,236 Military Parachute Descents. *J Roy Army Med Corps* 137:115-121, 1991.
31. Lindblad, B. E., K. Hoy, C. J. Terkelsen, H. E. Helleland. The socioeconomic consequences of sports injuries in Randers, Denmark. *Scand J Med Sci Sports* 1(4):221-224, 1991.
32. Linenger, J. M., S. Flinn, B. Thomas, C. W. Johnson. Musculoskeletal and medical morbidity associated with rigorous physical training. *Clin J Sports Med* 3(4):229-234, 1993.
33. Lysholm, J. , J. Wiklander. Injuries in runners. *Am J Sports Med* 15:168-171, 1987.
34. Macera, C. A., R. R. Pate, K. E. Powell, K. L. Jackson, J. S. Kendrick, T. E. Craven. Predicting lower extremity injuries among habitual runners. *Arch Intern Med* 149:2565-2568, 1989.
35. Macera, C. A. Lower extremity injuries in runners: Advances in prediction. *Sports Med* 13:50-57, 1992.
36. Marti, B., J. P. Vader, C. E. Minder, T. Abelson. On the epidemiology of running injuries - the 1984 Bern Grand-Prix study. *Am J Sports Med* 16(3):285-294, 1988.
37. Marti, B. Benefits and risks of running among women: An epidemiologic study. *Int J Sports Med* 9:92-98, 1988.

38. Miser, W. F., W. A. Lillegard et al. Injuries and Illnesses Incurred by an Elite Army Unit During the Invasion of Panama. *Soc Mil Orthop Surg*, El Paso, TX, 1991.
39. Pester, S., P. T. Smith. Stress fractures in the lower extremities of soldiers in basic training. *Orthop Rev* 21(3): 297-303, 1992.
40. Pollock, M. L., L. R. Gettman, C. A. Milesis, M. D. Bah, L. Durstine, R. B. Johnson. Effects of frequency and duration of training on attrition and incidence of injury. *Med Sci Sports Exerc* 9(1):31-6, 1977.
41. Protzman, R. R., C.C. Griffis. Comparative stress fracture incidence in males and females in an equal training environment. *Athletic Training* 12:126-130, 1977.
42. Protzman, R. R., C. G. Griffis. Stress fractures in men and women undergoing military training. *J Bone Joint Surg* 59(6):825, 1977.
43. Reinker, K. A., S. Ozburne. A comparison of male and female orthopedic pathology in basic training. *Milit Med* 144:532-536, 1979.
44. Requa, R. K., L. N. De Avilla, J. G. Garrick. Injuries in recreational adult fitness activities. *Am J Sports Med* 21:461-467, 1993.
45. Reynolds, K. L., H. A. Heckel, C. E. Witt, J. N. Martin, J. A. Pollard, J. J. Knapik, Jones, B. H.. Cigarette smoking, physical fitness, and injuries in infantry soldiers. *Am J Prev Med* 10:145-150, 1994.
46. Riddell, D. I. Changes in the incidence of medical conditions at the Commando Training Center, Royal Marines. *J Roy Nav Med Serv* 76:105-108, 1990.
47. Ryan, J. B., P. Amoroso, B. H. Jones, B. Bickley, D. Taylor, P. Leitschus. Impact of an outside-the-boot ankle brace on sprains associated with military airborne training. *Trans Orthop Res Soc* 19(2):653, 1994.
48. Samet, J. M., T. W. Chick, C. A. Howard. Running-related morbidity: a community survey. *Annals Sports Med* 1:30-34, 1982.
49. Schwellnus, M. P., G. Jordaan, T. D. Noakes. Prevention of common overuse injuries by the use of shock absorbing insoles: A prospective study. *Am J Sports Med* 18(6):636-641, 1990.

50. Scully, T. J., G. Besterman. Stress fracture - a preventable injury. *Milit Med* 147:285-287, 1982.
51. Shaffer, R. A., S. K. Brodine, S. A. Almeida, K. Maxwell-Williams, J. G. Aroden, S. D. Giebner. A predictive profile for stress fracture risk in US Marine Corps recruits. *Med Sci Sports Exer* 26(5), 1994.
52. Tomlinson, J. P., W. M. Lednar, J. D. Jackson. Risk of injury in soldiers. *Mil Med* 152(2):60-64, 1987.
53. Walter, S. D., L. E. Hart, J. M. McIntosh, J. R. Sutton. The Ontario cohort study of running related injuries. *Arch Intern Med* 149:2561-2564, 1989.
54. Watson, A. W. S.. Incidence and nature of sports injuries in Ireland: Analysis of four types of sport. *Am J Sports Med* 21:137-143, 1993.

CHAPTER 5

CASUALTIES DURING COMBAT DUE TO NONBATTLE INJURIES

Section 5-1. Introduction

a. Injuries that occur in a deployed military force are more likely to have an immediate and detrimental effect on the mission than those in garrison or training. These injuries have a direct impact on deployed personal and unit readiness and consume limited field medical resources.

b. The deployment environment contains myriad opportunities for injuries to occur. Although these opportunities may be present in garrison or on exercises, the deployed service person is more likely to be fatigued, exposed to dangerous materials, physically and mentally stressed, and operating in unfamiliar surroundings. Also, less emphasis may be placed on safety rules and procedures.

c. Complete, accurate, and timely surveillance data are required to effectively prevent and treat injuries during deployment. This chapter examines injury surveillance data collected during or after four recent missions: starting with Operations Desert Shield/Storm (ODS) in Southwest Asia (SWA), then Somalia, Haiti and Exercise Bright Star in Egypt.

d. It should be noted that while the focus of this chapter is injury surveillance the systems, techniques, and goals (i.e., reducing the number of unnecessary nonbattle casualties) are applicable to nontraumatic medical conditions. Ultimately, to think of injury surveillance systems as separate from illness surveillance would be a mistake. Both injury and illness surveillance are essential parts of an effective deployment medical surveillance system.

Section 5-2. Available Databases

The databases used to track nonbattle injuries are of two types, administrative systems established for other purposes (such as patient administration and casualty tracking) that can be used for medical surveillance and those set-up during a deployment for the specific purpose of conducting medical surveillance.

a. Fatalities during ODS.

(1) All active duty military deaths are reported by commanders to casualty offices in the respective service branches. Data for each death are recorded on a Report of Casualty

(DD Form 1300), entered into computerized databases and forwarded to the DIOR monthly. The computer files and copies of all casualty reports are stored at DIOR. The directorate has routinely collected all military fatality data for the DOD's Worldwide Casualty System since 1 October 1979.

(2) Each casualty report contains the date, location, cause, and circumstances of death, as well as data on demographics, next-of-kin, and survivor benefits. The circumstances of death reported on the form is abstracted from death investigation files. Each death is classified by casualty office personnel into one of six categories (accident, homicide, battle, self-inflicted, disease, and undetermined). Although, the casualty report is routinely prepared for reasons unrelated to medical surveillance it has been shown to be of considerable value as a source of complete data on active duty deaths.

b. Hospital Admissions during ODS (IPDS). For the Army, the Individual Patient Data System (IPDS), operated by the Patient Administration Systems and Biostatistical Activity (PASBA), at Fort Sam Houston, Texas, collects detailed data for each admission to all U.S. Army hospitals worldwide, including deployed field and combat support hospitals. Data from deployed hospitals in SWA during ODS, however, were not available for analysis until years after the operation. The IPDS morbidity data have proved to be quite useful for an historical study of in-patient visits to Army hospitals in SWA but less useful for real-time surveillance. Other services have systems similar to the Army's IPDS. The in-patient IPDS data presented in this chapter are Army-specific because we have not had any experience with similar data from the other services.

c. Routine Medical Surveillance During Deployments. In 1993, the Joint Staff mandated that outpatient medical surveillance with weekly reporting of rates of diseases and nonbattle injuries (DNBI), categorized by general type of illness or injury, should be conducted on all joint (Army, Navy, Air Force and USMC) deployments. Categories of DNBI collected by this Joint Service System are as illustrated in Table 5-1.

Table 5-1. Categories of Disease and Non-Battle Injury (DNBI) Used for Deployment Medical Surveillance (mandated by Joint Staff memo 28 Jan 93)

- | | |
|---------------------|---------------------|
| • Heat/cold injury | • Unexplained fever |
| • Gastrointestinal | • STD |
| • Dermatological | • Dental |
| • Respiratory | • Psychiatric |
| • Orthopedic/Injury | • Substance abuse |
| • Ophthalmic | |

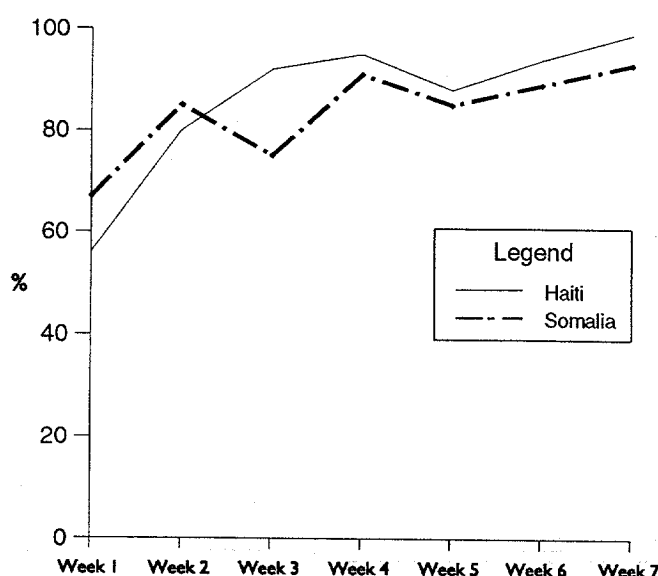
Note: Animal bites included as injuries; also, coding system needs an "other" or "miscellaneous" category.

(1) Surveillance efforts similar to that described by the Joint Staff had been designed and conducted by the Surgeon, 3d U.S. Army, and the Division of Preventive Medicine at Walter Reed Army Institute of Research on Bright Star exercises in Egypt since the mid-1980's. Medical surveillance was conducted on other exercises, like Cobra Gold in Thailand and Team Spirit in Korea, through the coordinated efforts of task force medical personnel, Navy Preventive Medicine Units, and others. However, ODS in 1990-1991 was the first large deployment where medical surveillance for an entire theater was attempted. Data for several component services, i.e., Marine Corps and Air Force, were collected but will not be discussed here.

(2) During recent joint operations in Somalia (1992) and Haiti (1994), comprehensive, uniform theater-wide surveillance was accomplished, using similar data collection systems. In Operation Restore Hope in Somalia, for example, the system included reporting of all outpatient clinic visits for approximately 90 percent of a 20,000-30,000 person-force on a weekly basis, and data on all hospital admissions to the two U.S. military hospital facilities in Somalia. Although data collection continued throughout the operation, the experience of the first seven weeks of the operation are included in this report. DNBI trends observed during these first weeks remained fairly consistent throughout the remainder of the operation. A similar approach was used for Operation Uphold Democracy in Haiti in 1994.

(3) Figure 5-1 demonstrates the extent to which medical treatment facilities during these deployments reported data through the surveillance system. Usually by the 3d to 4th week, over 90 percent of troops were covered by surveillance. This delay of several weeks was due to the fact that a surveillance system had to be newly created for each deployment.

Figure 5-1. Percent of Total Deployed U.S. Force Covered by DNBI Reporting System, by Week of Operation, Somalia and Haiti



d. Special Surveillance Study, Egypt. To determine types and patterns of injury occurring among military personnel deployed to the exercise logistics base at Cairo West, Egypt during Bright Star 94, records from the 146 patients treated for injuries at 47th Field Hospital from 23 October to 11 November 1993 were reviewed. All outpatient records were screened to detect those in which an injury was the chief complaint. Injuries were classified by type and body part injured, circumstance of injury, whether acute or chronic, and the immediate disposition of the injury.

Section 5-3. Magnitude of the Problem

The impact of injuries on deployed troops can be measured, in decreasing order of severity, by the number of deaths, hospital admissions and outpatient visits.

a. Fatality Rates during ODS. Nonbattle mortality data for ODS are presented in Table 5-2. Battle deaths, which are not included in the table, numbered 147. Unintentional trauma (accidents) were the leading cause of death reported during this deployment.

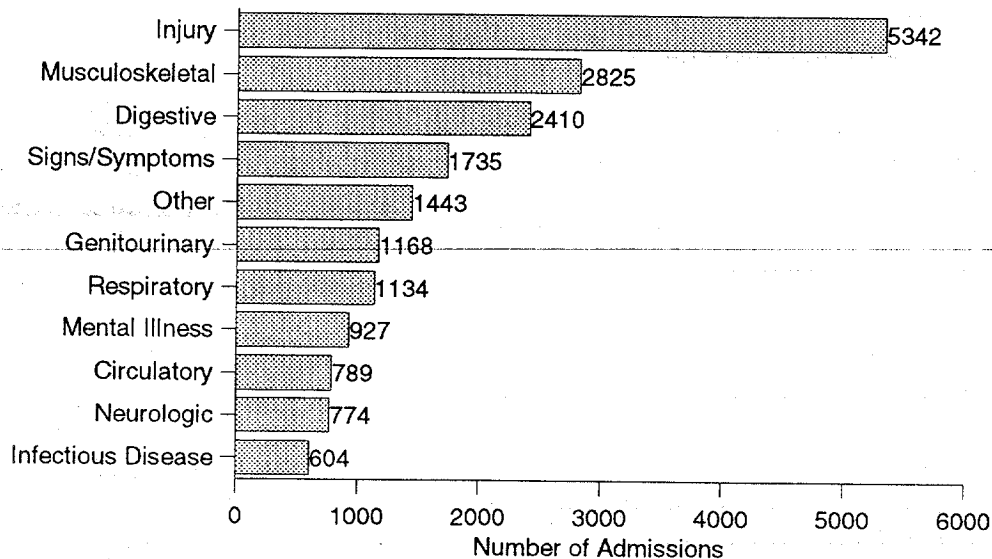
Table 5-2. Nonbattle Deaths in U.S. forces deployed to Operations Desert Shield and Storm, 1 Aug 90 - 31 Jul 91

Cause of Death	Number (%)	Rate (n/100,000/yr)
Unintentional Trauma (Accidents)	183 (81%)	69.1
Illness and Disease	30 (13%)	11.3
Self-inflicted	10 (4%)	3.8
Homicide	1 (0%)	0.4
Unknown	1 (0%)	0.4

*Rate per 100,000 person-years

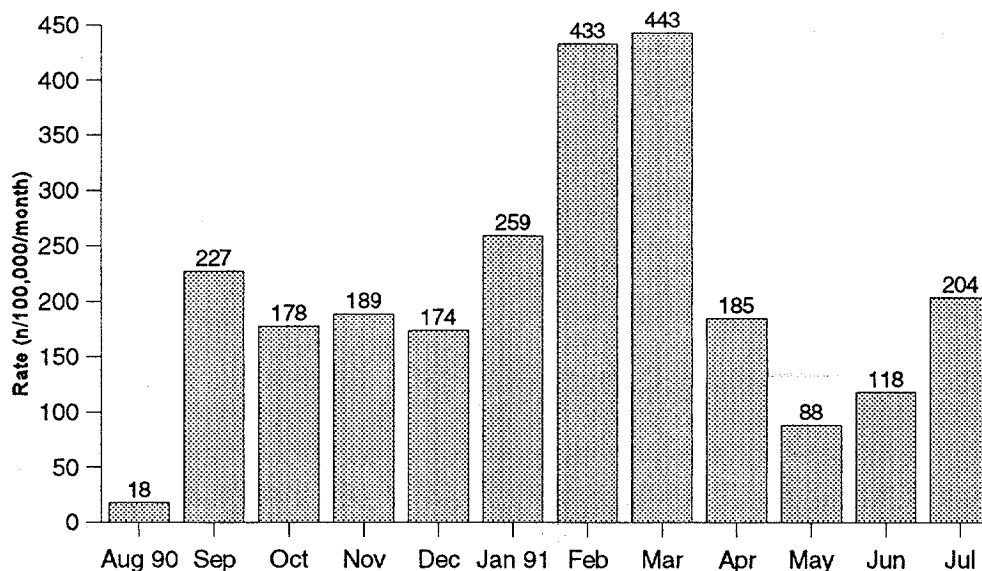
b. Hospital Admission Rates During ODS (IPDS). An analysis of the IPDS database shows that of 21,655 soldier admissions to Army hospitals in SWA during ODS, 5,342 (25 percent) were admitted for acute nonbattle injuries and 2,825 (13 percent) were admitted for conditions of the musculoskeletal system (Figure 5-2). In contrast there were only 956 battle-related admissions.

Figure 5-2. Leading Diagnosis Categories for U.S. Army Soldiers Hospitalized During Operations Desert Shield and Storm, 1 Aug 90 - 31 Jul 91



Admissions were reported throughout the deployment with the highest rates in February and March (Figure 5-3).

Figure 5-3. Rate (per 100,000) of U.S. Army Nonbattle Injury Hospitalizations in U.S. Army Soldiers Deployed to Operations Desert Shield and Storm, by Month, 1 Aug 90 - 31 Jul 91



Injuries accounted for approximately one-quarter of hospitalized days during ODS. There were 131,778 hospitalized days due to DNBI, 37,778 (29 percent) were injury related.

c. Injury Rates During Deployments.

(1) **In-Patient Care.** Injuries resulted in admission to one of the two hospital/holding facilities in Mogadishu, Somalia in the early weeks of Operation Restore Hope. Figure 5-4 shows the rate of admission, for all and selected causes. In the fall of 1994, approximately 20,000 U.S. troops deployed to Haiti during Operation Uphold Democracy. Inpatient data from Haiti showed rates of injury admission similar to those seen in Somalia.

(2) **Outpatient Care.** In Somalia, up to 32 medical treatment facilities at seven major sites were reporting outpatient data. Figure 5-5 shows the percent of troops seen each week for an illness or injury, categorized as per Table 5-1. Some of the smaller categories have been omitted from the figure for sake of clarity. Each week, 2.5 to 3.5 percent of troops were seen at aid stations for an injury or "orthopedic" problem. Unfortunately, no additional detail concerning the nature of these injuries or problems is available.³

Figure 5-4. Hospital Admission Rates by DNBI Category, 1st Medical Battalion (IMEF) and 86th Evacuation Hospital in Mogadishu, Somalia, Dec 92 - Feb 93 (Rate=No. of U.S. Military Personnel Admitted per 100,000 Troops per day)

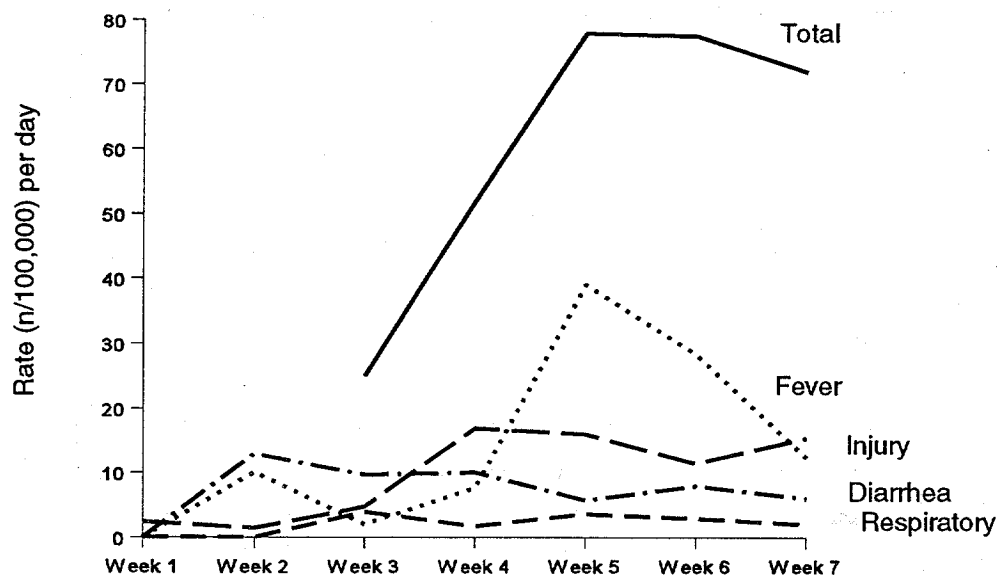
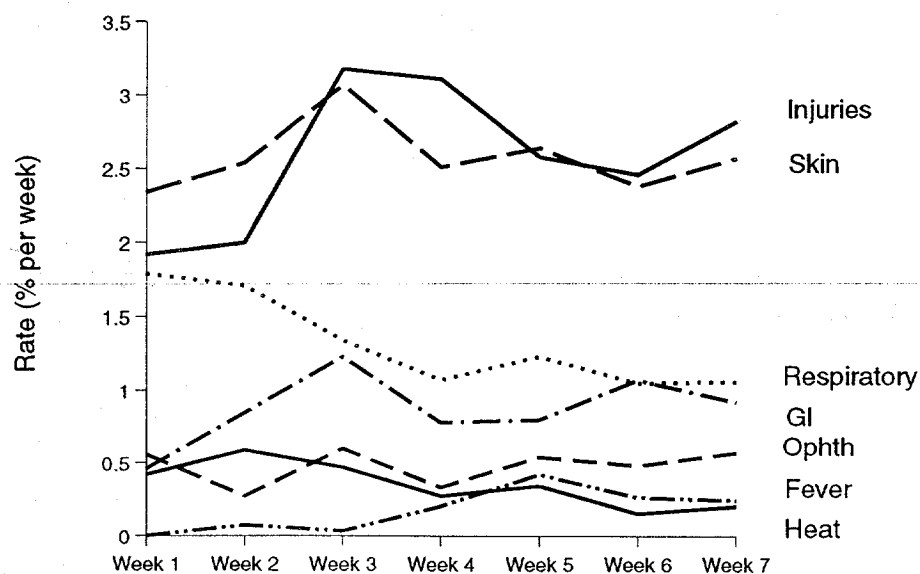


Figure 5-5. Outpatient DNBI, U.S. Forces in Somalia, 13 Dec 92 - 30 Jan 93 (= percent of troops diagnosed with injuries or illnesses in each Joint Staff category each week.)



For Operation Uphold Democracy in Haiti, outpatient data were collected in a similar manner. Injury rates in Haiti were similar to those recorded in Somalia; injury was the most common reason for outpatient visits in Haiti for three of the first five weeks of surveillance.

d. Frequency of Injuries From Surveillance Study, Egypt. The 146 injuries included in this study accounted for approximately one-fourth of all outpatient visits at the hospital over the 19 days of observation during the exercise (see Table 5-3 for frequencies of different types of injury). The disposition of the patient after injury was used as a surrogate measure of impact on readiness. Sprains and strains, the most common injury types, resulted in restricted duty profiles in 70 percent of cases. Back sprains resulted in quarters or restricted duty in 77 percent of cases. All five fractures counted in this study resulted in restricted duty; three were transferred out of theater.

Section 5-4. Type of Injury

Type and anatomic location of injuries can be useful in describing the epidemiology of nonbattle injuries and in focusing preventive measures. This information may be useful for allocating the proper amount and type of medical support for deployed troops.

a. Types of Fatalities During ODS. Mortality data collected by the casualty office do not include details of the type of injury resulting in death.

b. Types of Hospital Admissions During ODS (IPDS). Figure 5-6 shows the type of injuries reported to IPDS during ODS. Fractures were the leading reason for admission accounting for 1,324 (25 percent) admissions. Fractures were also the leading contributor to hospitalization days.

c. Types of Injury From Surveillance During Deployments. Deployment surveillance systems in Somalia and Haiti did not routinely collect detailed data on injury hospitalizations, such as types of injuries, or days hospitalized. Outpatient systems were also limited in the depth of information available; however, in Haiti, some additional information on types of injury are available. Figure 5-7 shows some additional detail concerning types of injury; puncture/laceration, low back pain, and fractures.

Figure 5-6. U.S. Army Nonbattle Hospitalizations Reported in U.S. Army Soldiers Deployed to Operations Desert Shield and Storm, 1 Aug 90 - 31 Jul 91

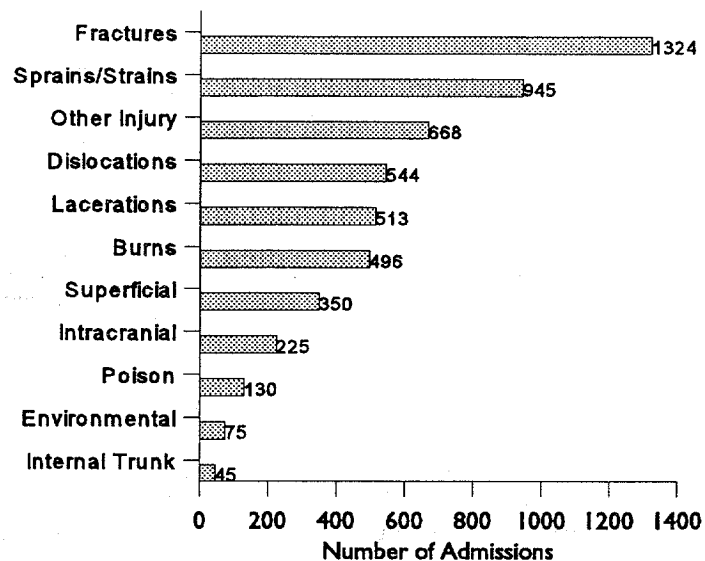
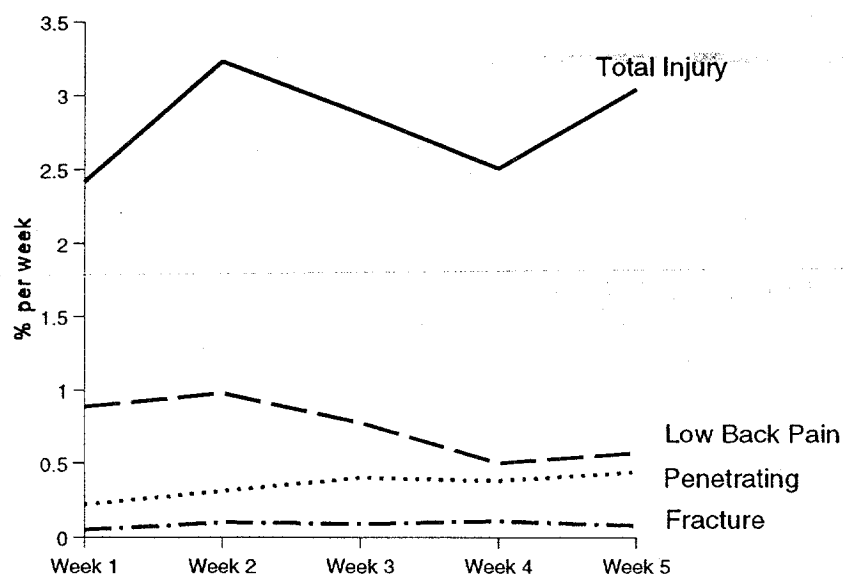


Figure 5-7. Outpatient Orthopedic/Injury DNBI Rates, Showing Additional Sub-Categories, Operation Uphold Democracy, Haiti, 2 Oct - 5 Nov 94
(% = percent of supported troops affected per week.)



d. Types of Injuries in Surveillance Study, Egypt. Table 5-3 shows the distribution of injury by anatomical region for the 108 injuries (of 146 total) for which type and location could be determined.

Table 5-3. Types of Injury Among U.S. Army Soldiers Examined at 47th Field Hospital during Exercise Bright Star, 23 Oct - 11 Nov 93

TYPE OF INJURY	LOCATION				Total
	Back	Upper Extremity	Lower Extremity	Other	
Sprain	22 (33%)	19 (29%)	21 (32%)	4 (6%)	66
Laceration	0 (0%)	12 (75%)	2 (13%)	2 (13%)	16
Crush	0 (0%)	6 (55%)	4 (36%)	1 (9%)	11
Blister	0 (0%)	0 (0%)	8 (100%)	0 (0%)	8
Fracture	0 (0%)	4 (80%)	1 (20%)	0 (0%)	5
Dislocation	0 (0%)	1 (100%)	0 (0%)	0 (0%)	1
Burn	0 (0%)	0 (0%)	0 (0%)	1 (100%)	1
TOTAL	22 (20%)	42 (39%)	36 (33%)	8 (7%)	108

Most (74 percent) of the injuries were acute problems, defined as occurring hours to several days before the visit; the remainder were either chronic or resulting from aggravation of past injuries. Back injuries were more likely than injuries of the extremities to be chronic (42 percent vs. 21 percent).

Section 5-5. Causes, Mechanism and Circumstances of Injury

Injury prevention requires information on the causes and mechanisms of injuries. Collection of this information has been incomplete in the administrative and surveillance databases described.

a. Causes of Fatalities during ODS. Transportation accidents were the leading cause of nonbattle death in all U.S. forces deployed to ODS. Motor vehicle accidents accounted for 62 of 183 nonbattle injury deaths (34 percent). These were followed by aircraft accidents at 47 nonbattle deaths (26 percent).

b. Causes of Hospital Admissions During ODS (IPDS). For injury surveillance the most useful field in the IPDS database is the one for cause of injury. This field uses a coding system developed for NATO. The cause of injury codes are designed for use in a military population and are, therefore, more useful and informative than the ICD-9 E-codes.

For example, injuries caused by weapons can be coded to the level of detail of type of weapon, during or not during battle, and caused by enemy or friendly fire. Unfortunately, a specific cause of injury was not assigned in 2664 (50 percent) of the records. Table 5-4 shows the six leading causes of injury hospitalization during ODS.

Table 5-4. Selected Causes of Injury Among Hospitalized U.S. Army Soldiers Deployed to Operations Desert Shield and Storm, 1 Aug 90 - 31 Jul 91

Cause of Injury	Number (%)	Rate*
Motor vehicle accidents	566 (19%)	4.0
Falls	559 (19%)	4.0
Sports and athletics	512 (18%)	3.6
Machinery and tools	398 (14%)	2.8
Other land transport	126 (4%)	0.9
Weapons	113 (4%)	0.8

*Rate per 1000 person-years

Figure 5-8 shows how the cause of injury data can be combined with the type of injury data. Such information may be useful in designing specific injury prevention programs based on cause and type of injury.

Figure 5-8. Hospitalizations for MVA Injuries Reported Among U.S. Army Soldiers Deployed to Operations Desert Shield and Storm, 1 Aug 90 - 31 Jul 91

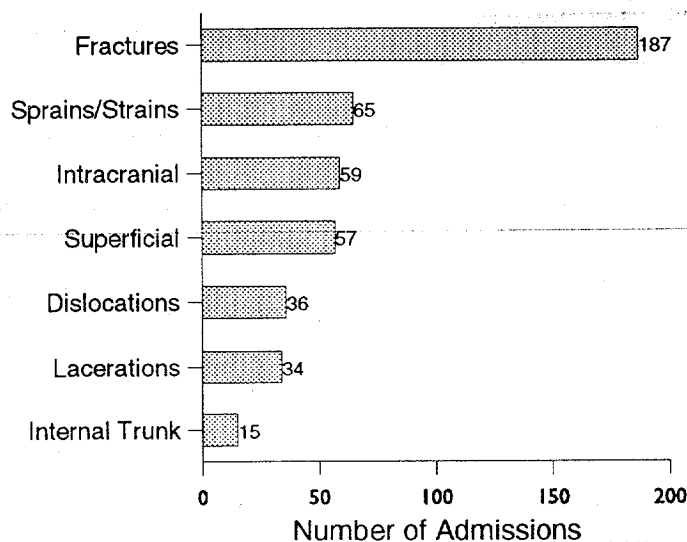
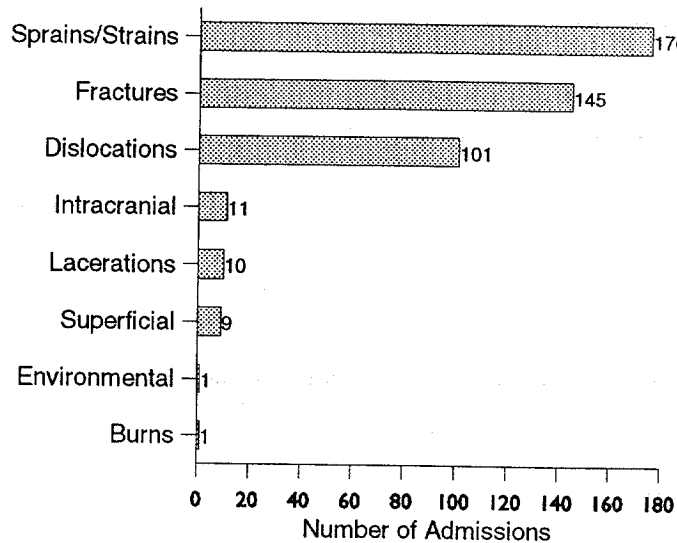


Figure 5-9. Hospitalizations for Sports and Athletic Injuries Reported Among U.S. Army Soldiers Deployed to Operations Desert Shield and Storm, 1 Aug 90 - 31 Jul 91



c. Causes of Injury During Deployments. Deployment surveillance systems in Somalia and Haiti did not routinely collect detailed data on cause or circumstances of injury.

d. Causes of Injury During Surveillance Study, Egypt. Sports or recreation were implicated in 26 percent of the 95 injuries (39 percent of all sprains) for which appropriate information was available. Twelve injuries occurred while playing basketball, followed in frequency by volleyball (5) and football (4). Back injuries were more likely to be associated with lifting (59 percent) and moving heavy objects.

Section 5-6. Strengths and Limitations of Existing Databases

a. Casualty Reports (Fatalities).

(1) Strengths

- ◆ Already Computerized
- ◆ Easily Accessible
- ◆ Complete
- ◆ Accurate
- ◆ Timely; done monthly
- ◆ Ongoing investigations may result in more accurate cause of death data

(2) Limitations

- ◆ Limited information type, cause and circumstance of injury death
- ◆ Nonspecific, only six broad categories readily available

b. Hospital Admissions during ODS (IPDS)

(1) Strengths

- ◆ Already computerized
- ◆ Standardized medical database
- ◆ Uses ICD-9 codes, using up to 8 per admission
- ◆ Includes military-specific cause of injury codes
- ◆ Admissions are coded as trauma or nontrauma
- ◆ Details of diagnosis, disposition, demographics available
- ◆ Easily obtained
- ◆ Hospital and sick days available

(2) Limitations

- ◆ Military hospitals only
- ◆ Significant delay, 3 years after ODS, in getting data
- ◆ Completeness and accuracy during deployments not validated and unknown
- ◆ Almost 50 percent of cause of injury codes do not identify a specific mechanism

c. Routine Medical Surveillance during Deployments

(1) Strengths

- ◆ Comprehensive, full coverage of deployed force is possible
- ◆ Rapid turn around, e.g., weekly
- ◆ Simple data collection and entry
- ◆ Provides for unit/population bases surveillance

(2) Limitations

- ◆ *Ad hoc* efforts during deployments leads to delays in data collection
- ◆ Not standardized between deployments
- ◆ Requires oversight for quality control
- ◆ Limited details available on type, cause and mechanism of injury

- ◆ No personal identifying information, no linkage to other records
- ◆ Data must be collected, entered and reported in a field environment.

d. Special Surveillance Study, Egypt

(1) Strengths

- ◆ Feasible in field settings
- ◆ Can be tailored to a specific situation and to answer specific questions

(2) Limitations

- ◆ Requires dedicated resources
- ◆ *Ad Hoc* effort
- ◆ Can detract from routine surveillance
- ◆ Cannot generalize to other situations.

Section 5-7. Conclusions and Recommendations

a. Injuries were the leading cause of death and a leading cause of hospital admissions and outpatient visits during recent deployments. Data on injury incidence extracted from existing databases can be used for surveillance purposes, with some of the limitations as noted above. Surveillance systems established during deployments have also provided useful and timely information. Both of these sources are important components of a comprehensive military medical surveillance system. However, they can be improved. The following recommendations are designed to build on the strengths of these systems.

b. Medical surveillance should be an essential element in monitoring the medical readiness of the military. This activity should be a routine and essential preventive medicine function of deployed and nondeployed forces.

c. Standardize the deployment surveillance system across the services. Personnel from the Army, Navy, Marines and Air Force should be using the same data collection forms and techniques. The form and techniques may vary from conflict to conflict, or even between theaters in a conflict but a core form should be established.

d. The data collection form should be short and simple to use. A data collection form that becomes a burden to medical personnel will not be used. It is extremely important that only essential information and not extraneous data be collected. Check-boxes should be used where possible rather than text descriptions.

e. Timely reporting of collected data to medical and line commanders and medical units collecting data is essential. Data should be routinely analyzed and reported to those responsible for the medical readiness of the force and those in military command. Ideally, injuries should be classified in at least three ways;

- (1) Type of injury
- (2) Location of injury
- (3) Cause of injury

The type of injury should be classified into 6 to 10 categories such as; fractures, sprains/strains, lacerations/open wound, superficial wound/contusion, burn injury, heat/cold injury, internal trunk, intracranial or multiple trauma. The location of injury should be classified as; head, neck, arm, hand, trunk, leg, foot, etc. The mechanism of injury should be classified into 6 to 10 categories such as; motor vehicle, aircraft, fall, sports/athletics, firearm, shell/bomb/mine, machine/tool, or fire. Although this data would be useful in assessing types and causes of injuries, the need to keep the surveillance system as simple as possible may preclude routine collection at this level of detail.

f. Surveillance is not a substitute for research. Injury epidemiology and control research should be conducted to determine circumstances surrounding injury, identifying risk factors for injuries, and evaluating injury prevention, treatment, and rehabilitation strategies.

CHAPTER 6

CONCLUSIONS AND RECOMMENDATIONS

Section 6-1. Conclusions

a. The magnitude and pervasiveness of the problem with injuries in the Military services warrants a coordinated effort to prevent, control and monitor its impact. Controlling a problem of the scope and complexity of injuries requires a well planned, systematic approach. Injury control in the 1990s (AAAM, May 1993), a report to the Second World Conference on Injuries, proposed a national plan for the United States which could serve as a model for the military. The plan advocates the public health approach which entails definition of the problem, identification of causes, development and testing of intervention strategies, implementation of intervention programs and measuring effectiveness. The five steps of the public health approach to injury prevention and control can be summarized in the form of five questions (Rosenberg, M., Director's Update, Department of Health and Human Services Advisory Committee Meeting, 28 March 1994):

- (1) How big is the problem?
- (2) What causes the problem?
- (3) What works to prevent the problem?
- (4) Who needs to know and what do they need to know?
- (5) How effective are our efforts?

The success of this approach clearly depends on information systems to answer these questions.

b. The critical questions posed to the Armed Forces Epidemiological Board Injury Prevention Work Group were:

(1) How big is the problem with injuries for the Military services relative to other medical conditions?

(2) What information systems exist to focus and support comprehensive injury prevention and control programs?

(3) How can existing information systems be used to effectively prevent injuries?

The Work Group analyzed data from existing military data sources on deaths, disabilities, hospital admissions, and outpatient clinic visits to address these questions.

c. From its review the Work Group concluded that injuries are the leading peacetime threat to the health and readiness of U.S. Military Forces. Evidence from Vietnam and SWA suggest that nonbattle injuries may be the number one "enemy" of soldiers and marines in combat as well (Palinkas and Coben, *Milit Med*, 1988; Writer, Section 5). The next and perhaps most important conclusion was that the infrastructure and data sources exist to conduct comprehensive medical surveillance for injuries and other health problems.

d. A brief summary of some of the information that led the Work Group to these key conclusions and others regarding the problem with injuries will help to understand both the value of the potential surveillance databases and the nature of the problem with injuries.

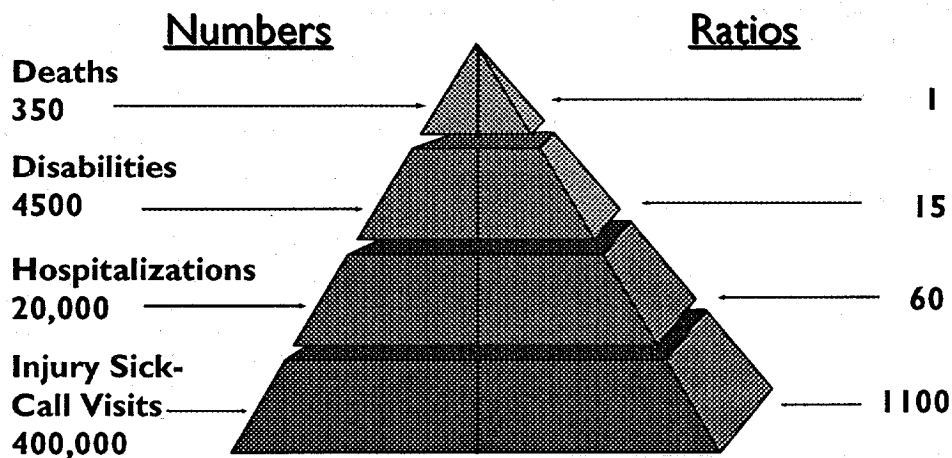
e. The Work Group's conclusion that injuries are the number one health problem of the Military services should be no surprise. It is well documented that injuries are the leading cause of death and disability among young Americans in general (NAS, *Injury in America*, 1985; Rice, DP et al *Cost of Injury in America*, 1989; PHS, DHHS, *Healthy People 2000*, 1991) and the Military is a young population with an average age in the mid-20s. The Work Group saw data that showed injuries cause more deaths among military personnel in all of the services than any other cause. Four out of every five deaths among service personnel are due to injuries. The Work Group also reviewed data documenting that injuries to military personnel exert a major impact on more than just fatality rates.

f. With the possible exception of the Air Force, injuries and orthopedic complaints result in more disabilities, hospital admissions and noneffective days for the Military services than any other cause. The Work Group saw data for the Military indicating that roughly one out of two disability discharges result from injury or orthopedic complaints and 2 to 3 out every ten hospitalizations. In 1992, hospitalizations for musculoskeletal condition and injuries in the Army alone resulted in more than 500,000 noneffective soldier days either in a hospital bed or on convalescent leave.

g. The Work Group found that while less is known about injuries treated in outpatient clinical settings, it has been estimated from Army studies that the total numbers of personnel affected are large. For 1992, a conservative estimate suggests that 450,000 or more outpatient clinic visits were made for injury complaints and that these would have resulted in several million days of restricted duty. Data presented to the Work Group and published in the open literature suggest that for the Army and Marine Corps basic trainees and infantry in particular a substantial proportion, 75 percent or more, of these injuries result from vigorous, physically demanding training (Jones, BH, *Sports Med*, 1994, Knapik, J, *JOM*, 1993, Reynolds, K, *Am J Prev Med*, 1994).

h. The Work Group reviewed data from the Army on the number of soldiers dying, receiving disability evaluations, being admitted to a hospital and seeking outpatient care for an injury. Ratios were calculated comparing the number of soldiers in a particular category to the number of soldiers who died for a given year. Figure 1 shows the injury pyramid constructed from these Army data for 1994. The Work Group concluded from this and other data that injuries treated in outpatient clinics have the biggest impact on the readiness of the Army. The group also speculated that this is probably true for the other Services as well.

Figure 6-1. Army Injury Pyramid*



* Based on CY 1994 Army Population and Data
** Estimated from Research Results

BHJ12065

i. The medically-related databases maintained by the medical and personnel departments of the services contain information on both the types and causes of injuries. From disability, medical evaluation board, and hospital databases the Work Group identified back complaints and derangements of the knees as important sources of morbidity. Fractures and sprains were determined to be leading types of injury resulting in hospital admissions, outpatient visits and temporary disability during both peacetime and combat operations. From hospital discharge data, the Work Group identified sports, motor vehicle accidents, and falls as leading causes of injuries. Data such as this should be used to focus and prioritize prevention programs and research.

j. Military epidemiologists showed the Work Group study results identifying a number of risk factors for overuse, training-related injuries which are the most common injuries seen in military outpatient clinics. These risk factors, which have also been reported in the peer reviewed literature, include excessive amounts of training (Jones, Sports Medicine, 1994), low levels of physical fitness (Jones, Am J Sports Med, 1993, Knapik, J JOM, 1993, Reynolds, K 1994) and smoking cigarettes (Jones, Med Sci Sports Exerc, 1993 and Reynolds, K 1994), among others. From these data the Work Group concluded that the medical and research databases maintained by the military services provide an excellent foundation for future research and prevention strategy development. However, the resources allocated for research appear small compared to the magnitude of the problem with injuries.

k. Reports on a successful intervention trial of an ankle brace to prevent parachute jump-related injuries and other trials indicated to the Work Group that the expertise and research capability exists for developing effective prevention strategies. The Work Group also viewed data from several databases tracking trends in morbidity and mortality. Most notably fatality rates for all the services have been declining for at least the past decade and a half. Also, over this period of time hospital admission rates for injuries sustained due to motor vehicle crashes have been decreasing. It was of interest to the workgroup that for the Army the "late effects of injury" had been steadily increasing over the last 15 years to the point that it was the leading cause in 1992. Thus, it was evident to the Work Group that all the services possess databases capable of testing and monitoring the effectiveness of prevention strategies and identifying emerging hazards. The data reviewed also showed that focused safety and prevention efforts can reduce injury rates.

l. The Work Group concurred that the information sources exist to provide answers to the key questions necessary to systematically prevent and control injuries:

(1) How big the problem with injuries is for the military?

(2) What causes the problem?

(3) What prevents it?

(4) How effective are efforts to prevent it?

However, the available information sources need to be routinely utilized to be of value.

m. The Work Group concluded that all of the medically-related databases reviewed had potential value for surveillance. The databases with immediate potential include:

deaths from the DOD Directorate of Information and Operational Reports and service casualty offices, disabilities from the service disability agencies and boards, and hospitalizations from the medical records systems. However, because the records of outpatient encounters that include diagnoses are not yet automated, the group felt that surveillance of injuries treated in the ambulatory care setting is farthest from actualization. The database of most immediate value for injury surveillance and prevention is the hospital records database.

Section 6-2. Recommendations

a. Future military injury prevention successes will depend on reliable surveillance systems and research. Development of injury surveillance systems is a key national and international health objective (NAS, *Injury in America*, 1985; PHS, *Healthy People 2000*, 1991; NCHS, *Proceedings of the International Collaborative on Injury Statistics*, 1995). Successful prevention and control of injuries and other public health problems requires surveillance to identify problems, to prioritize allocation of resources, to focus research and prevention programs, and to monitor program effectiveness. Fortunately for the U.S. Military, some of the necessary databases on health outcomes and military populations already exist.

b. After examining data from relevant military medical and administrative databases, the Work Group felt that the primary requisite for the services at this time is to begin using the available information sources for medical and injury surveillance in addition to their other administrative uses. Therefore, the foremost recommendation of the Work Group is that the Medical Departments of the Military services establish automated, population-based, medical surveillance systems linking hospitalization, disability and fatality databases at a central site. The Work Group also recommended that outpatient and combat/deployment surveillance systems be developed. All these systems should track, analyze and report on rates of injuries, not just frequencies, over time and across different populations and locations.

c. To be useful surveillance data must be valid, reliable, and comparable for different populations. Several recent reports make specific recommendations to assure the validity, reliability, and comparability of injury surveillance data (NCHS, *Proceedings of the ICE on Injury Statistics*, 1995; PHS, *Healthy People 2000*, 1991).

d. The Work Group made several recommendations that they felt were particularly important to assure the quality and comparability of the data. These recommendations were to:

(1) Collect at least the minimum basic data sets recommended by the International Collaborative Effort on Injury Statistics (see Addendum B).

(2) Standardize collection, coding, coding practices, and reporting of injuries across the military services.

(3) Improve collection of cause of injury data

(4) Refine definitions and coding of work and nonwork related injuries for military personnel.

(More specific recommendations can be found in Appendix A). The Work Group also felt that episodic assessment of the completeness and validity of the data in the different databases would be very important.

e. The Work Group recommended that the surveillance databases be used to focus research and prevention program development on the most important problems (i.e., those with the highest incidence, greatest amount of associated disability or severity and for which there was promise of a solution). It was further recommended that the medical surveillance databases be used to aid in prioritizing allocation of resources for research and prevention programs for both injuries and diseases predicated on the same above priorities. The medical and administrative databases reviewed are particularly well suited for this purpose because of completeness of information and the ability to look at all diagnostic categories of injury and disease for a variety of outcomes (i.e., death, disability, hospitalization, etc.).

f. In order to be of value, however, the surveillance data system must be linked to prevention and control activities. Development and implementation of prevention strategies requires a multidisciplinary scientific approach involving specialists in epidemiology, safety, biomechanics, medicine, and other professions (NAS, Injury in America, 1985). Successful prevention programs in the civilian world require coordination of community partners, such as fire and police departments, hospitals, schools, community leaders, engineers, and others (National Committee for Injury Prevention and Control, Injury Prevention Meeting the Challenge, *Am J Prev Med*, supplement to volume 5, number 6, 1989). A key requisite for ongoing success of military injury prevention and control efforts will be coordination and linkage of the essential partners in the military community.

g. To answer the one remaining key public health question - Who needs to know and what do they need to know?, the AFEB Injury Prevention Work Group recommends that a Tri-Service Injury Prevention and Control Workshop be held. The workshop would bring

together members of the AFEB Injury Prevention Work Group and the DOD Directorate of Safety and Occupational Health Policy Injury Surveillance and Prevention Work Group, representatives of the service Safety Centers/Agencies, representatives from each of the databases with surveillance potential, representatives of the military medical research organizations and other key medical and operational stakeholders from each of the services. The purpose of the workshop would be to:

(1) Lay the conceptual foundation for comprehensive, integrated injury surveillance, prevention and control programs.

(2) Establish partnerships and communications links necessary for successful prevention and control programs.

(3) Identify other key injury prevention and control stakeholders.

(4) Set short- and long-term priorities for coordination and implementation of future Injury Surveillance, Prevention and Control Efforts.

h. The diligent efforts of the DOD Injury Surveillance and Prevention Work Group have unveiled the full extent of the "hidden epidemic" of injuries in the Military. This Work Group, the AFEB Injury Prevention Work Group, has reviewed the data amassed by its companion DOD Work Group and concluded that injuries are the leading cause of deaths, disabilities and requirements for medical care in the Military Services. Furthermore, the AFEB Work Group has determined that the costs of injury in terms of manpower losses and monetary expenditures are large. The Work Group has concluded that injury rates in the military can be reduced and that the information systems which provided the data examined are an excellent and necessary foundation for future injury prevention and control efforts in the Military. Much work, however, remains to be done to link the other key safety and prevention partners in the Military community to those information systems.

i. Finally, the AFEB Injury Prevention and Control Work Group does not view this report as an end in itself but rather the beginning of a process that will reduce injury rates and costs to the Military Services. Prevention of injuries, as well as disease, is the ultimate goal of both military medical surveillance and research.

References

1. Association for the Advancement of Automotive Medicine (AAAM). *Injury Control in the 1990s: A National Plan for Action*. Second World Conference on Injury Control, 1993.
2. Jones, B. H., D. N. Cowan, J. P. Tomlinson, J. R. Robinson, D. W. Polly, P. N. Frykman. *Epidemiology of Injuries Associated with Physical Training Among Young Men in the Army*. Med. Sci. Sports Exerc. 25(2): 197-203, 1993.
3. Jones, B.H., M.W. Bovee, J.M. Harris, D.N. Cowan. *Intrinsic Risk Factors for Exercise-related Injuries among Male and Female Army Trainees*. Am J Sports Med. 21(5): 705-710, 1993.
4. Jones, B. H. *Exercise, Training, and Injuries*. Sports Medicine. 18(3): 202-214, 1994.
5. Knapik, J. J., P. Ang, K. L. Reynolds, B. H. Jones. *Physical Fitness, Age, and Injury Incidence in Infantry Soldiers*. JOM. 35(6): 598-603, 1993.
6. National Academy of Sciences. *Injury in America*. National Academy Press, Washington, D.C., 1985.
7. National Center for Health Statistics. *Proceedings of the International Collaborative Effort on Injury Statistics, Volume I*. National Center for Health Statistics, Hyattsville, MD, 1995.
8. Palinkas, L. A., P. Coben. *Disease and Non-Battle Injuries among U.S. Marines in Vietnam*. Milit Med. 153: 150-155, 1988.
9. Public Health Service. *Healthy People 2000*. U.S. Government Printing Office, Washington, D.C., 1991.
10. Reynolds, K. L., J. A. Pollard, H. A. Heckel, J. J. Knapik, C. E. Witt, B. H. Jones, J. W. Martin. *Cigarette Smoking, Physical Fitness, and Injuries in Infantry Soldiers*. Am J Prev Med. 10(3): 145-150, 1994.
11. Rice, D. P., E. J. MacKenzie, and Associates. *Cost of Injury in the United States: A Report to Congress*. Institute for Health and Aging, University of California, San Francisco, CA and Injury Prevention Center, The Johns Hopkins University, 1989.

CHAPTER 7

CONCLUSIONS AND RECOMMENDATIONS OF THE AFEB

Section 7-1. Conclusions

a. The AFEB has, for many years, been provided with information regarding the impact of injuries in selected settings, special circumstances, or in limited populations within the military. While these "snapshots" were informative, an overall vision of the scope and magnitude of the injury epidemic was not fully appreciated. This report of the AFEB Injury Work Group is a first, and important step towards more completely understanding the problem, identifying risk factors, developing prevention and control strategies, and evaluating those interventions. The AFEB congratulates the Injury Work Group and accepts this report.

b. The report makes it clear that injuries have a direct and costly impact on the health and readiness of U.S. Armed Forces and that this impact exceeds any other category of medical complaint during peacetime or combat.

c. The Injury Work Group report demonstrates the potential for development of a comprehensive medical surveillance system covering the full spectrum of health from outpatient care to disabilities and deaths. The identification of injuries as the leading health problem of the military across the spectrum of health demonstrates the value of medical surveillance for focusing and prioritizing prevention and research programs.

d. While the report presents information from a myriad of sources, from all services, from medical, disability, and mortality files, it was extremely labor intensive because the information/data sets were independent, unlinked, and widely distributed across the services. In this time of computer technology, there is no defensible reason not to convert or create systems that embody the concept of interconnectivity to allow these kind of analyses to be accomplished easily and in a timely fashion.

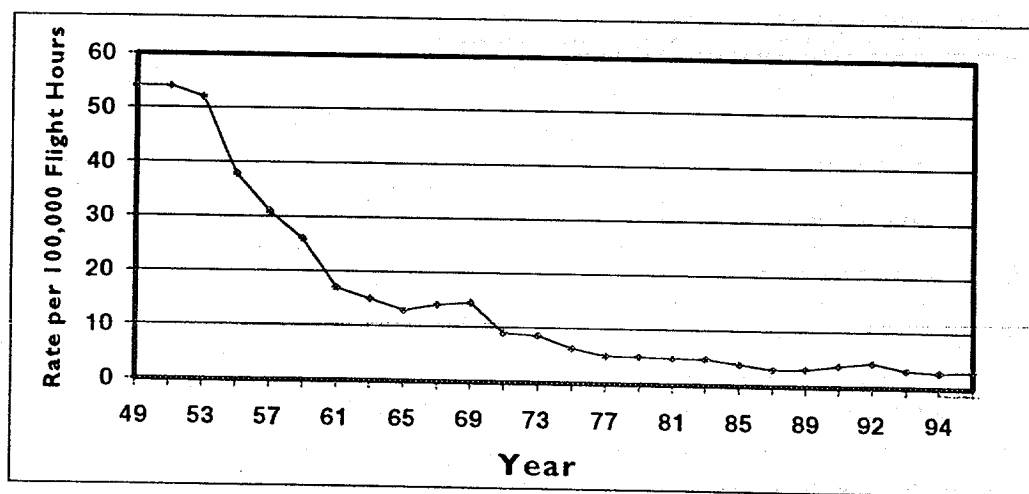
e. The value of military surveillance systems will be further enhanced if they are standardized and compatible with civilian systems. Also, although differences in the epidemiology of injuries exist between the military and the general U.S. population, as well as within the services, prevention and control lessons learned in civilian communities may have implications for military populations. Likewise, many interventions developed or evaluated by the military can provide important examples for civilian injury prevention activities.

f. The successes of the military in reducing the number, rate and severity of injuries suffered by military personnel and recruits are important to highlight. Some of these successes... the reduction of Navy aviation fatalities (Figures 7-1A & 7-1B), Army motor vehicle fatalities (Figure 7-1C), injuries in Marine recruits, or development of ankle support to prevent injuries in paratroopers (Chapter 4, Figure 4-2) not only demonstrate the commitment of the services to injury prevention and control, but also serve as testimony that sound interventions work. Ready availability of data from the previously untapped resources outlined in this report should permit the military services to achieve successes in preventing injuries from other causes similar to those for aviation and motor vehicle crashes.

g. The AFEB concludes that the Military Medical Departments can make significant contributions to the future success of injury prevention programs. That success depends not only on development of comprehensive medical surveillance systems but also on strengthening partnerships with the Service Safety Centers and line commanders who have the primary responsibility for preventing injuries.

Figure 7-1A.

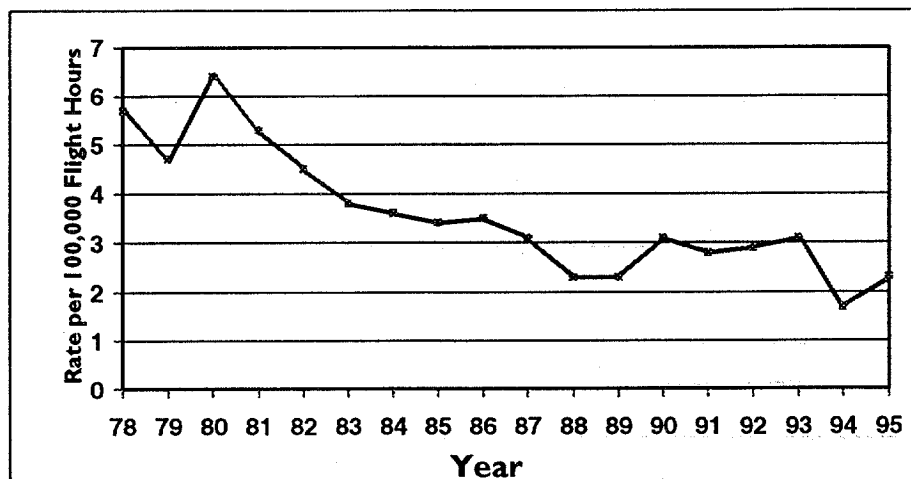
Navy Aviation Fatalities 1949-1995



Naval Safety Center

Figure 7-1B.

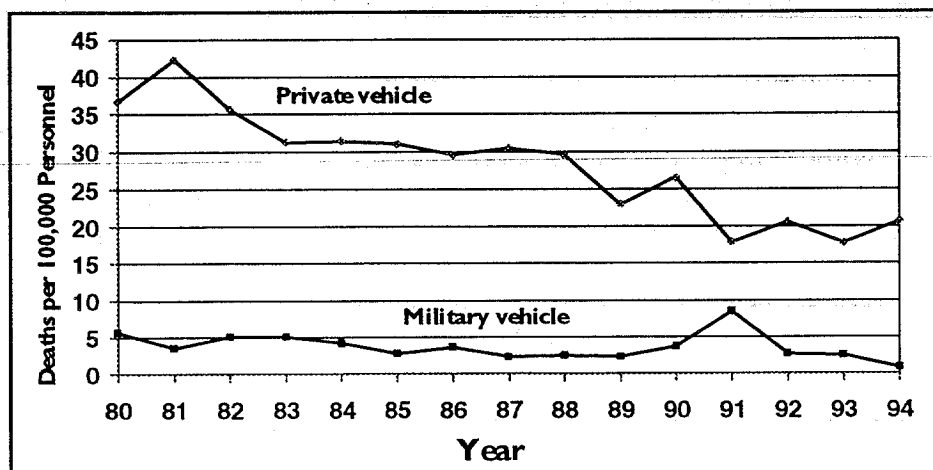
Navy Aviation Fatalities 1978-1995



Naval Safety Center

Figure 7-1C.

Army Motor Vehicle Fatalities 1980-1994

Army Safety Center Data
Special Report, 1995

Section 7-2. Recommendations of the AFEB

- a. The AFEB accepts the report and the findings and recommendations made within.
- b. The AFEB further recommends that an integrated, tri-service injury prevention and control effort be organized among existing work groups to continue to emphasize the importance of injuries as a preventable cause of significant morbidity, disability and premature mortality. The AFEB offers epidemiologic consultation and support to this effort.
- c. The tri-service effort should include a wide array of medical, safety, research, and surveillance groups within the military. Outside injury experts from other federal and state government agencies, academia and industry should be invited to participate and contribute as needed. Cooperation in understanding the causes of injuries and improving prevention strategies may not only enhance military readiness but also benefit the general population.
- d. High quality data, accessible to injury prevention and control researchers within the military are vital. To that end, the AFEB strongly encourages the tri-service effort to begin with a complete inventory of databases that would be useful to injury (and disease) prevention and control activities. Such databases might include hospitalizations, sick call, disability, safety center data, death records and others. The quality of existing data sources should be evaluated. Also, information gathered by the services should be standardized across databases to facilitate linkage and interpretations. The AFEB further recommends that significant energy, time and resources be expended in pursuit of connectivity among the various health and safety databases.
- e. In addition to the injury issues identified in this report which focused primarily on unintentional ("accidental") injuries, the AFEB felt sources of data on intentional or violent injuries (homicides and suicides) should be identified and explored. Another specific issue deserving further

Military Injury Prevention Successes

All three military services, Army, Navy, and Air Force place great emphasis on prevention of aviation and motor vehicle deaths. The Navy has tracked the occurrence of aviation fatalities since 1949. Navy safety programs have successfully lowered the fatality rates from 54 per 100,000 flight hours in 1949 to 4 per 100,000 flight hours in 1994 (Figures 7-1A and 7-1B). The Army and Air Force can show similar aviation injury prevention successes.

Army Safety Center data show that fatal injuries due to both privately owned and military vehicle crashes have declined by about 50 percent between 1980 and 1994 (Figure 7-1C). The other services, like the nation as a whole, have had tremendous success preventing motor vehicle fatalities. The success of aviation and motor vehicle safety programs illustrates three key ingredients of successful injury prevention programs: 1) clear prevention targets, 2) systems to monitor program effectiveness, 3) strong support of leadership. These dramatic decreases in aviation and vehicle crashes in the military also suggest the degree of success that can be expected when resources are committed to prevention of injuries.

attention is the relationship of alcohol and drug use to the occurrence of both unintentional and intentional/violent injuries.

f. The AFEB emphasizes the importance of allocating adequate resources to develop medical and injury surveillance capabilities and to ensure viability of injury research programs within the Medical Departments.

g. The AFEB recommends that a comprehensive tri-service medical surveillance system be developed and that the effort to prevent injuries serve as a model for the process of controlling public health problems from both injuries and disease.

APPENDIX A

SUMMARY CONCLUSIONS AND RECOMMENDATIONS FOR EACH REPORT CHAPTER*

Section A-1. Deaths

A-1-1. Conclusions

- a. Injuries today are the leading cause of death in all three services with "accidents" causing >50 percent of all deaths.
- b. Injury deaths have decreased steadily since 1980, especially accidental deaths.
- c. Deaths in the military do not have a big impact on readiness in terms of total numbers.
- d. The Marine Corps experiences the highest rates of injuries which includes accidents, homicides, and suicides.
- e. The Air Force experiences the lowest injury rates.
- f. Overall injury rates are lower for women.
- g. Rates of homicide for women are higher than for men.
- h. Infrastructure exists for complete surveillance of deaths.
- i. For purposes of prevention, more detailed information is needed than is routinely reported on casualties, especially for nonaccidents (i.e., intentional injuries).

A-1-2. Recommendations

- a. Collect and report more detailed, standardized data on deaths and death rates.
- b. Collect the same level of data for all deaths as done by the National Center for Health Statistics, include at least the minimum basic data set recommended by the International Collaborative Effort on Injury Statistics (see Appendix B).
- c. Collect a free text field on circumstances and cause (90 characters).

*From 5 July 1995, Injury Work Group Meeting.

- d. Examine the medical, safety, and casualty databases for demographics, causes, etc., with attention to completeness and complementarity.
- e. Determine the percentage of injury deaths captured in hospital databases.
- f. Explore other databases with relevant cause/circumstance data (possible sources may be the Military Police Records, Line of Duty Investigations, Hospital Records, Judge Advocate General Records, etc.).
- g. Identify high risk populations and target for prevention.
- h. Devote more resources to prevention of violent injuries and nonfatal injuries.
- i. Evaluate and validate the accuracy and completeness of current databases.

Section A-2. Disability

A-2-1. Conclusions

- a. Orthopedic complaints are the leading cause of disability for the Army, Navy and Marine Corps resulting in at least 30 percent to 50 percent of Physical Evaluation Board (PEB) cases.
- b. Impact of disabilities on manpower is high - 1 to 2 percent of service members are evaluated annually; 60 percent are discharged or permanently retired.
- c. Costs of injury related disability probably exceed \$750 million annually.
- d. Disability rates appear to be climbing for the Navy and the Air Force and declining for the Army.
- e. Low back and knee conditions are leading causes of disability at the PEB level.
- f. Disability agency data provides a valuable data source for defining the impact of injury on both manpower and costs.
- g. Medical Evaluation Board (MEB) data from the services are a good source of more precise diagnoses but data is not computerized for the Army or Air Force.
- h. Preventive measures are not readily apparent from disability agency data.

i. Line of duty (LOD) data might be used to determine causes of injury-related disabilities.

A-2-2. Recommendations

- a. PEBs and MEBs should be used for medical and injury surveillance.
- b. Collect Minimum Basic Data Set recommended by ICE and episodically assess completeness and validity of PEBs and MEBs (see Appendix B).
- c. Link PEB/MEB data to other medical databases and denominators.
- d. Compare standardized rates of disability/injury among services.
- e. Obtain better demographic and cause-of injury data to supplement PEB/MEB for disabled/injured database-look at LOD's and similar success.
- f. Determine the percentage of injury-related MEBs that reach the PEB level.
- g. Automate and centralize MEB data systems.

Section A-3. Hospitalization

A-3-1. Conclusions

- a. Hospital records data indicate that injuries and musculoskeletal conditions have a bigger impact on readiness than any other ICD-9 Principle Diagnostic Group (higher incidence, higher noneffective rate).
- b. For the Army, injuries and musculoskeletal disorders accounted for 30 percent of hospital admissions (28,000) and 40 percent of soldier noneffective days (over 500,000 days on the hospital rolls) in 1992.
- c. Hospitalization rates for injury appear to be declining for all services (1980-1992).
- d. Musculoskeletal disorders are increasing in the Army but declining in the other services.
- e. Major causes of hospitalization include sports injuries, motor vehicle accidents, falls, and jumps.

- i. Examine work vs. nonwork related injury (cross cutting all databases).
- j. Evaluate process and quality of data for military active duty treated in civilian hospitals.
- k. Add free text field for detailed cause of injury information to help design and evaluate prevention strategies.
- l. Evaluate "late effects of injury" and complications of medical/surgical care.
- m. Link hospital and disability data to evaluate long-term effects of injury.
- n. Assure adequate collection of causes, to include possible E-coding for musculoskeletal injuries (pilot project at sentinel sites).

Section A-4. Outpatient

A-4-1. Conclusions

- a. Research indicates that high injury rates occur in basic training, infantry and other vigorously active military units.
- b. For Army, injury visit rates are equal to illness rates in basic training and infantry units (80 to 100 injury visits per 100 soldiers per year).
- c. Injury noneffective rates (i.e., rates of days of limited duty) are 5 to 10 times greater than illness rates.
- d. Lower extremity overuse injuries account for the majority of training related injuries.
- e. Modifiable injury risk factors include the amount and type of physical training and level of fitness.
- f. No uniform service-wide outpatient surveillance systems yet exist which includes injury diagnoses and causes.
- g. One pilot surveillance system in use at Navy/U.S. Marine Corps and Air Force training sites may be a useful model.

- h. Most research has been done on basic training, with some on Infantry and Marines, but there have been few studies on other types of units.
- i. Testing of training injury prevention strategies has provided successful interventions and cost savings.

A-4-2. Recommendations

- a. Sentinel site surveillance or other cost effective outpatient surveillance system is needed until automated outpatient records are available.
- b. Include in the minimum data set for outpatient care, at least the following; age, race, gender, diagnosis, profile/disposition, and cause.
- c. Focus research on high risk populations and environments with largest impact on readiness.
- d. Document incidence, severity, time lost, and costs.
- e. Conduct research to study the effect of equipment design on training and injuries.
- f. Broaden research effort to more than basic training and infantry.
- g. Research on physical training practices should concentrate on the intensity, frequency, and duration of training, as well as the type of activity.
- h. Continue to explore the association of training, fitness, performance, smoking and injuries.
- i. Implement and monitor effectiveness of prevention strategies.
- j. Allocate/ prioritize resources for research based on magnitude and severity of medical problems -injuries clearly deserve priority.

Section A-5. Casualties During Combat

A-5-1. Conclusions

- a. Injuries and musculoskeletal conditions cause more hospitalizations during combat than any other category of medical complaints (ICD-9 Principle Diagnostic Group).

- b. For the Army, 38 percent of hospital admissions during ODS resulted from injuries and musculoskeletal disorders.
- c. Injuries are an important cause of outpatient "sick call" during combat deployments.
- d. Fractures, back injuries, and knee injuries are important types of injuries causing hospitalizations of Army Personnel in combat operations and most recently in ODS.
- e. Sports, falls, and MVA's are important causes of injury in combat.
- f. Good data on hospitalizations are available, but delay of availability during operations limits value.
- g. Surveillance is possible during operations but needs to be refined and standardized across services.

A-5-2. Recommendations

- a. Use medical surveillance to monitor readiness in peacetime and combat.
- b. Standardize deployment/combat medical surveillance systems across services- these should be integrated with garrison medical surveillance systems .
- c. Keep collection of data short and easy for medical personnel to perform.
- d. Provide weekly reporting of medical surveillance data to line commanders and medical units.
- e. Collect data on the following at a minimum: date, type of injury, anatomical location, and cause/circumstance of injury.
- f. Train medical personnel in methods and uses of medical surveillance.
- g. Identify problems to target for more intense investigation and prevention through analysis of surveillance data.
- h. Improve communication systems to support routine surveillance and data transmission in combat.

APPENDIX B

Section B-1. Minimum Basic Data Set Required for Intentional/Violent Injuries¹

Age of victim and perpetrator

Sex of victim and perpetrator

Race of victim and perpetrator

Time and date of injury event

Type of injury/body location

Place of occurrence (home, work, school, etc.)

Address of place of occurrence

Circumstances or motive surrounding injury event

Drugs or alcohol involved (yes/no)

Weapon(s) involved

Relationship of victim to perpetrator

Outcome measurement appropriate for data source (days in hospital, degree of disability, etc.)

Source of data

Intent

¹ Powell, K., and Kraus, J. *Minimum Basic Data Set - Intentional Injuries*. In *Proceedings of the International Collaborative Effort on Injuries*. Vol 1., p. 35-1, 35-2, 1994.

Section B-2. Minimum Basic Data Set Required for Unintentional Injuries²

Age of victim

Sex of victim

Race of victim

Residence of victim

Date of injury event

Place of occurrence (home, school, work, etc.)

Address of place of occurrence

Activity when injury occurred (work, education, sports, etc.)

Mechanism of accident/event

Type of injury/body location

Outcome measurements appropriate for data source (days in hospital, cost of care, degree of disability, etc.)

² Lund, J., Holder, Y., and Smith, R. *Minimum Basic Data Set (MBDS), Unintentional Injuries*. In Proceedings of the International Collaborative Effort on Injuries, Vol 1., p. 34-1 - 34-4, 1994.